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ABSTRACT

This study examined ways in which microcomputers are used in schools and the complex issues that surround their implementation. Three fictional geographically distinct school districts with a diversity of microcomputer applications at both the elementary and secondary levels were studied: Salerno, a large southern city; Granite, a midwestern city; and Greenview, a small suburban community in the northeast. A research team interviewed people at all levels of the school system--district administrators, school administrators, computer resource personnel, media specialists, teachers, students, and community persons. Students were observed using computers in a variety of contexts. Six trends emerged which raise important questions for future research: (1) differential access to microcomputers; (2) the emergence of new roles in response to microcomputers; (3) the lack of integration of microcomputers into elementary classrooms and curriculum; (4) the inadequate quality and quantity of software; (5) the inadequate preparation of teachers for using microcomputers; and (6) the lack of knowledge of effects and outcomes. Interview guides and a classroom observation form are appended, and 69 references are listed. (Author/MES)

Study of Issues Related to the Implementation of Computer Technology in Schools

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Mari Endreweit, Karen Billings

Technical Report No. 2

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Final Report

July, 1981

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Bank Street College of Education

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PREFACE

The study reported here was conducted in order to discover and identify ways in which microcomputers are now being used in schools, and the complex issues which surround their implementation. The purpose of the study was to assist the National Institute of Education in setting priorities for research in the area of new technology and education.

Because our goals were to discover problems and issues, rather than to conduct a systematic survey, we used case study methodology. We selected three different school systems which were using microcomputers in elementary and secondary schools and looked carefully at what was happening at each site. Our researchers came to the project with varied points of view, and the participants we interviewed had differing perspectives on microcomputer activities in their school systems. In the pages that follow we have described what we saw and were told at each site, as well as the issues that emerged as being most salient.

Our study was descriptive, not evaluative. We reported the positive effects which participants told us about as well as the problems which were part of implementation at each site. We did not attempt to compare sites with each other by some standard of success or achievement. Just what such a standard might be, given the varied forms of implementation we observed, is in itself a very difficult question.

This report is organized into five chapters. In the introduction, literature is reviewed which serves as a background for the design and methods of the study. Chapters two through four constitute the three case studies. Chapter five is a discussion of the trends, problems and issues which emerged as most salient from this research.

Although a draft of each case study has been reviewed by participants at the respective site, we, the authors, take full responsibility for what is presented here.

We would like to thank all of the people at our sites and pilot sites who gave so generously of their time. Kenneth C. Laudon provided a critical reading of this manuscript and helped us to maintain a sociological perspective throughout the research. Laura Bryant's careful work turned a multitude of notes and scribbles into a readable manuscript.

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ABSTRACT

This exploratory, multidisciplinary study identifies a research agenda for the educational implementation and impact of microprocessing technology. Sociological research on the impact of computers in organizations suggests a rich set of implications to explore, the central one being that implementation and impact occur within social and political contexts. Individuals and groups who use technology, plan for its use, and evaluate it powerfully shape its effects. The organizational levels in an educational system - community, school, classroom, and individual teachers and students - provide the structure for investigating the issues which follow from the sociological, psychological, educational and technological perspectives which inform this study.

Three geographically distinct school districts with a diversity of microcomputer applications at both elementary and secondary levels were studied. A research team interviewed people at all levels of the school system--district administrators, school administrators, computer resouce personnel, media specialists, teachers. students, and community persons. Students were observed using microcomputers in a variety of contexts.

In general, school systems used microcomputers in ways consistent with their own goals, needs and ways of operating. In Salerno, a large southern city, authority and resources were centralized. The school district is eager to improve students' scores on basic skills, and the microcomputer is one way to further that goal. The district itself has developed a comprehensive basic skills mathematics package for students who are below grade level in grades one through eight. In most schools, students use micros in a resource room on an individual basis.

In Granite, a midwestern city school district, some resources and authority are centralized, but actual use of microcomputers and decisions about use are made within each school. A state organization coordinates and facilitates instructional computing at all levels of education. While there is broad commitment to computer literacy, teachers themselves decide how to use computers with their students. At the elementary level, there is a wide range of uses of micros, while at the secondary level micros are generally part of math and business courses.

In Greenview, a small suburban community in the northeast, decision-making about microcomputers is primarily at the grass roots level, with central administrators providing support and encouragement. In many schools teacher buffs have emerged--teachers knowledgeable and enthusiastic about using microcomputers who are eager to involve others in

their use. Micros are used for many purposes at the elementary level, and primarly for literacy and programming at the secondary level.

Six trends emerged which raise important questions for future research. These are: (1) differential access to microcomputers, (2) the emergence of new roles in response to microcomputers, (3) the lack of integration of microcomputers into elementary classrooms and curriculum, (4) the inadequate quantity and quality of software, (5) the inadequate preparation of teachers for using microcomputers, and (6) lack of knowledge of effects and outcomes.

CHAPTER ONE

INTRODUCTION

Background Literature

The technological developments of the past decade, which have resulted in the increasing memory capacity and decreasing cost of microprocessor chips, herald a new era of technology in education (Bell, 1979; Hakansson & Roach, 1979; Langenes, 1978; Molnar, 1975). In the recent past, schools wishing to provide computers for their students had to invest large sums of money in equipment and/or communications costs for time-sharing systems, as well as in trained personnel. These constraints resulted in computer uses primarily by large education systems willing to invest large sums of money in technology--the state of Minnesota being a primary example.

With the coming of the microcomputer--inexpensive, portable, easy to use and maintain--much more widespread use of technology in education is now possible. An interested teacher or administrator, who only a few years ago would have had to persuade a state or city school board to make a commitment of $10,000 to $20,000 per terminal to a time-sharing system (Luehrman, 1979), need only persuade the PTA to donate a $1,000 microcomputer. Indeed, some PTA's initiate such a donation.

Overall, then, the personal computer fits the essentially local, decentralized nature of education in the United States. Not only can local decisions be made about its purchase, but also about its use. A teacher can, at least in principle, make decisions about how to use the computer in the classroom, without being dependent upon a central computing and software facility. Because the cost, portability, local control, and ease of maintenance of the microcomputer makes it much more accessible to schools than were previous systems, there is an enormous potential for increased instructional use, scope, and personalization.

But a piece of equipment does not a revolution make. Oettinger (1969), in his thoughtful essay on computers in education in the pre-microprocessor era, concluded that there was much in the very structure of education which mediated against effective innovation--a system which he characterized as rigid, yet fragmented, lacking either centralized authority or genuine flexibility. Within the classroom, Oettinger claimed, pedagogy and curriculum were unchanged by access to a computer.

While some may disagree with Oettinger's judgment, or question his lack of empirical evidence, few would claim that the promise of instructional computing in the early

1960's was realized (Bunderson & Faust, 1976). And, while the new technology does differ in many important respects from the old, expectations about educational impact must be viewed cautiously. There are many steps between putting a machine, albeit a powerful, engaging machine, into a classroom and making a difference for children and teachers.

Equally as important as recent technological developments are contributions from the fields of artificial intelligence, psychology, and education which have expanded the vision of how computers might be used in the classroom. The computer-assisted instruction approach, well-developed, documented, and widely implemented (Suppes & Morningstar, 1972), puts the learner in a relatively passive stance vis-a-vis the computer and emphasizes drill and practice. New approaches, in contrast, emphasize placing the learner in an active role. Giving the child the initiative, enabling the child to take control and be the "teacher" of the computer, is thought to facilitate powerful learning in many areas (Papert, 1971; Bork, 1975; Dwyer, 1975; Bamberger, 1972).

However, the knowledge which children need to be in control of computers, as well as the educational context for such mastery, are difficult to put into practice. Teachers must determine whether this kind of use is consistent with their educational philosophy and their school's curriculum. If so, they must take time to learn how to make these approaches work in their classroom. It is much less demanding of teachers to switch on a drill and practice program than to help a student master the machine or to create software which enriches the curriculum. Moreover, administrators and school boards may want drill and practice in the hope of improving students' standardized test scores.

Even though we now have both a powerful technology and creative ideas about how to use it to enhance education, we do not know enough about implementing computer programs in schools, and what the effects of the new technology are likely to be on children's education. The technology is so new, there has not been time to study it. Fortunately, there is already a large research literature on computer implementation in other kinds of organizations. Sociologists have looked carefully at the implementation and effects of computers in private industry, government, and the military for many years. A review of this literature provides a rich source of information from which hypotheses can be formulated about education.

The Sociological Perspective on the Social Impact of Computers

Social science work in the area of the social impact of computing can be divided into three broad areas of concern:

1. Social factors in implementation: studies of invention, diffusion, initiation, design/planning, and implementation.

2. The organizational impact of computers: studies of change in information flow, decision-making, the balance of power among organizational sub-groups, and changes in the nature of work.

3. Critical social values: studies of equity, social and political accountability, professionalism, program goals and service quality.

Each of these areas is discussed below.

Social Factors in Implementation

In the last decade the key insight brought to the study of society and computers by social scientists has been that "computers do not impact society like two ships colliding in a stormy sea" (Laudon, 1974). Instead, what one observes is a complex interaction of technological development, market forces, professional and popular ideologies, and powerful interests and values. To be sure, technology and society are reciprocally related (Mesthene, 1972). But for social scientists and historians the most interesting questions are the ways in which society affects the use of technology (Winner, 1977; Westin, 1968; Mowshowitz, 1976; Rule, 1974; Anderson, 1979). This perspective is reflected in research on social processes of diffusion, organizational initiation, and implementation.

Most of the historical work on the development of computers has been done by computer scientists, especially those closely associated with this early history (Wiener, 1954; Weizenaum, 1977; Goldstine, 1972). Early "rationalist" views on the development, design, and implementation of computing systems emphasized organizational "needs" and technological requisites (Simon, 1965, 1977; and Licklider and Vezza, 1978). These views have been replaced by research which emphasizes the socio-political environment, political economy of organizations, and specific mechanisms of implementation. Laudon (1974, 1977), Danziger and Dutton, (1977), Kling, (1978), Kraemer (1977), and Danziger, et al, (1981) have documented the role played by interpersonal factors such as trust and credibility in effecting the adoption of computers in the public sector. Similar conclusions have been reached about the private sector. Interpersonal factors are more significant than technical merits of system design (Pettigrew, 1973). While the size and productive nature of an organization are important (Gerson and Koenig, 1979; Danziger, et al, 1980), they alone do not account for the adoption of one system

over another.

In the areas of design and implementation of computing systems, social scientists have had perhaps their largest effect. Numerous studies have documented that a lack of "user" participation in system requirements' specification, software development, and organizational role contribute to system "failure." Failure includes low utilization, rejection, or misuse (Keen and Gerson, 1977; Kling and Scacchi, 1979; Alter and Ginzberg, 1978; Keen and Morton, 1978; Lucas, 1975; Mumford and Banks, 1967). Nowhere has this been more apparent than in the development of "management information systems" (Markus, 1979; Laudon, 1974; Danziger, et al, 1981).

It is important to note that these studies were done in the late 1960's and early 1970's. Now that many organizations have developed their own internal expertise, the tendency to impose systems "from the top down" may have lessened. The development of micro and minicomputers, distributed processing, and inexpensive message switching networks may also have reduced the difficulties of adjusting system capabilities to user needs. This possibility, however, raises new research issues with regard to management control, security and integrity.

Organizational Impacts

Speculations in the 1960's about the computer's impact on organizational life presumed an almost limitless organizational ability to collect, store, and process information, presumed the development of precise analytic schemes to describe social reality, and finally, presumed the emergence of a new technically trained management elite capable of defining policy options and outcomes (Bell, 1973; Brzezinski, 1967). These ingredients were thought to assure more rational decision-making, a shift of power towards central managers and experts, (Downs, 1967), and an upgrading of work skills for much of the working population. Some see these as positive developments. Others are concerned about the possibilities of job obsolescence and loss of skills, the decline of organizational pluralism, and the growth of huge centralized institutions (Galbraith, 1978). Research on computers and organizations in the 1970's has been unable to confirm either of these views.

The computer's impact on organizational power relationships is ambiguous. Computers can be used as a tool to facilitate centralization of budgetary and political authority (Laudon, 1974). They can also be used by agencies and departments to insulate themselves from domination by central management (Markus, 1980; Colton, 1978). In highly differentiated and complex federal-state systems, such as

the FBI's National Crime Information Center, or federally-funded state disability systems, central authorities may impose standards but are less able to determine the use and function of information by local authorities (Laudon, 1980; Westin, Boduslaw, and Hoffman, 1979). Perhaps the safest generalization here is that computerized information systems tend either to reflect or reinforce existing patterns of power and authority (Kling, 1974; Danziger, et al 1981).

Recognizing that computers have not changed organizational decision-making or power arrangements in fundamental ways does not mean that they are unimportant. Computers have had a large impact on program administration, budgetary procedures, inventory control, production process control, forecasting, and planning procedures. They have provided significant "technical benefits" such as more and better reporting, faster information retrieval, faster decision-making, and more efficient use of resources. All of these improvements have benefited management, employees, customers and clients. These consequences, however, do not add up to the revolution in organizational life that was predicted a decade ago. Such predictions overestimated the power of information processing relative to other forces, and underestimated the diverstiy of American organizational life into which computers had to fit.

The most controversial and least empirically grounded area of computer organizational impacts concerns the effect of computers on work. Computer-based administration and production control systems have restimulated an unresolved debate of the 1950's over the impact of automation on work. Here there is no shortage of opinions. Bell (1973), Meyers (1970) and others in the "information society" tradition forecast the growth of information and knowledge-based jobs, and a further transformation in which specialists and professionals are relieved of time-consuming and repetitive work. Braverman (1974), Briefs (1979) and others predict that management will replace unreliable "human machines" with more reliable general purpose machines and will routinize white collar work. This will bring about a decline of self-expression in work, closer supervision of workers, decimation of middle management, and finally, "de-skillization" of both blue collar and professional work (See also Argyris, 1973; Mann and Williams, 1960; Whisler, 1970; Mumford and Bank, 1967; Noble, 1977). These concerns are so intense in Europe that several Scandinavian societies have statutes mandating that workers participate in systems development projects (Nygaard, 1979; Anderson, and Jappe, 1979).

Empirical research on technology and work life has been infrequent (especially in the United States), unsystematic, and over-generalized. In a series of studies, Laudon found

that social workers' fear of a loss of skills did materalize when they were replaced by clerks using computerized data bases to make welfare decisions; that police feared and thus successfully resisted closer supervision with the advent of computerized command/control systems; but that social security workers were highly receptive to a data-base system that gave them more information and more rapid retrieval, as well as up-graded their skills and pay. On the other hand, Laudon found that criminal court judges feared the loss of autonomy vis-a-vis state and federal criminal justice systems which keep track of their decisions and their productivity (Laudon, 1974; 1980). Some researchers have found that the use of computerized systems led to a degradation of skills among mechanics (Noble, 1977) and a loss of job complexity among tobacco workers (Albin, Laudon, & Weinberg, 1979). Others have found, however, that among white collar and clerical workers, automation results in modest increases in job skills, job significance, and job pressures with little change in job satisfaction (Kling, 1978; Anderson, and Jappe, 1979).

Thus, contextual variables (such as the national political context, the nature of the occupation, social and economic factors, and the goals of management) are all significant in mediating the influences of computers on work life.

Critical Social Values

The rapid development of computer technology--as with previous technologies--has raised a number of broad issues related to social values. Insofar as computers threaten or alter social values and institutions, they offer opportunities to address these issues. It is, however, difficult to separate a perceived threat from actual impact. Nevertheless, the public perception of technology, and of computers in particular, is an important factor in shaping the use of technology both through market forces and government programs.

Privacy, confidentiality, and freedom of information are well-known issues commonly associated with the development of public and private data banks (Westin and Baker, 1972). More recent but perhaps less well known concerns are equity, accountability, professionalism, service quality and program goals. Problems of equity arise insofar as societal subgroups have differential levels of access and training in the use of new information tools. In recent Congressional studies there has been a growing interest in these problems (Office of Technology Assessment, 1979; Laudon, 1980, 1979). When traditional legislative mechanisms become incapable of overseeing high technology programs, problems of legal and political accountability arise (Kling, 1978; Laudon, 1980). Because information

technology is better suited to some organizational goals than others, problems of program balances arise; e.g., police arrest functions vs. prevention of crime, math programs vs. literature programs in CAI packages (Colton, 1978). Making efficiency and cost-saving the primary goal of information systems may have negative impacts on service quality, especially when data bases are allowed to deteriorate or when the mystique of an information system supplants common sense judgment (Sterling, 1979; Laudon, 1980; Anderson, 1979). Finally, problems of professionalism arise when computers become obstacles in the client-professional relationship, when they operate as administrative supervision instruments rather than freely chosen tools, and when they reduce the discretion allowed to professionals.

The negative impacts of information technology outlined above may, of course, never occur. A decade of research on the relationship between information technology and society justifies the conclusion that computers do not in any simple sense affect society. Information technology appears to be more socially malleable than other technologies, and it appears to be developing along lines which permit greater degrees of freedom in its use. It is the users of the technology--people, organizations, institutions--which shape its impacts.

Implications of Sociological Review for Current Study

Many implications can be drawn from the sociological literature about possible issues in the implementation and impact of microcomputers in education. The chief implication is that the computer does not have any simple "impact" on an organization or the people in it. Its implementation and use are embedded in a complex system of social and political relationships. At all levels of implementation and use, we need to consider the interaction of the computer with the social system which surrounds it. We also need to understand how this interaction changes over time, as computing activities influence the social system and the social system shapes the influence of the technology. This recognition of the interactive nature of the relationship between the computer and the social system informed our approach to the study. Put briefly, the implementation of computers in classrooms was seen to reflect events at many levels of the school system. All of these levels were investigated.

Conceptual Framework

The conceptual framework of this project was derived from the different structural levels defining the context for the implementation and impact of microcomputers: the community, the school system and school, the classroom, and

the individual child and teacher. Decisions which are made, events which occur, and beliefs which are held at each level may ultimately affect the nature and scope of the impact of the computer on children and teachers in classrooms. The questions we raised and hypotheses we suggested at each level were informed by a number of perspectives--those of the sociologist, developmental psychologist, educational curriculum specialist, educational researcher, and instructional computing specialist. The "structural levels" approach permitted all of our concerns to be included, while at the same time presenting a multidisciplinary framework.

In general, we saw the four levels as a set of nested variables. The local community, the school system, and the school are thought of primarily as independent variables which affect the next two levels - the classroom and the individual teacher and children in it. The classroom environment may be a dependent variable with respect to the organization of the school, but an independent variable with respect to the functioning of individual children and teachers.

The process of implementation can have effects, not only at the individual teacher and child levels, but also at other structural levels. Authority relationships and educational values are examples of factors which may change as a result of the complex set of events which make up the technological and educational innovation.

Issues which this research was intended to uncover can emerge at any level. Yet they are likely to have origins and effects at more than one level. The combined concern with the sociological, educational, psychological and technological issues made it possible for us to suggest how events at one level, such as the school system's administration, can ultimately have important impact on the education and development of students in classrooms.

Research Questions

In this section, some of the more salient questions which informed this study at each organizational level are described. Others are easily inferrable from the interview and observation guides included in the appendix (See Appendices A and B).

Community. The community context for the school system and microcomputer implementation was investigated. Some communities, because of the work life and/or value systems of its adults, are more supportive of computers in education than are others. We wanted to identify which factors in each community were related to computer use. Questions about the local economy and about specific

community input to school decision-making were important here.

School System and School. Since computers tend to reflect and reinforce existing patterns of authority and influence, we expected that decisions about the computer--what to buy, who should have it, where it is to be lodged, and what it is used for--would be made by persons who are in roles of power and authority.

On the other hand, the low cost and portability of microcomputers make it possible for the existing structure of authority to be bypassed. A "top down" political process may not be required to put one microcomputer into one classroom. We investigated the process by which computers got into classrooms, as well as the degree of teacher participation in this process. Moreover, we wanted to know whether the degree of teacher participation in decision making and planning for microcomputer use was related to scope of implementation.

We also asked about the rationale and purpose for the introduction of computers. While efficiency is an argument often used in support of computing in education, (Bunderson and Faust, 1976) the goal of efficiency may be detrimental to teacher morale and productivity. Other goals however, may elicit support and agreement. The purpose and philosophy of a school's computing program and how widely agreed-upon that view is within the school were both central questions.

Questions about access, interest and familiarity with computers were also important. We wanted to know whether students who used computers extensively made up a small subset of the student population based on such factors as sex, achievement level, or socioeconomic level. Connected to the issue of differential use of the computer was that of a computer subculture--a group of students (and perhaps teachers) who spent a great deal of time with the computers during and after school. We wanted to know if such groups existed, and, if so, whether they were large or small, inclusive or exclusive, and ones which other students wish to be a part of or to avoid.

Classrooms. At the level of the individual classroom, the intended and actual uses of the computer were compared. We were aware that computers intended to alter the process of teaching and/or learning could be used in ways which paralleled, and perhaps reinforced, ongoing practices (Fullan, 1972). We felt it was critical to know whose intentions were being put into practice and how they were implemented.

Regarding the computer as a mode of instruction in the

classroom, we asked what effect it had on other modes of instruction, such as the teacher, peer teaching, or audiovisual modes. Did the computer, for example, lessen the likelihood of children working together and being together in a classroom? Did it change the nature of the teacher's role a classroom, for example, from one who gives instruction to one who facilitates instruction through the computer?

Closely related to these issues was whether the computer--both in terms of the subject matter for which it was used and the way in which children interacted with it--was integrated into the classroom curriculum. Did it enhance and strengthen the curricular goals in the classroom, was its use unrelated to these goals, or did it detract from them in some way?

Questions of power, authority, and access were also relevant at the classroom level. Was a classroom social structure reflected in who used the computer for what, and under what circumstances? Did the computer, in fact, change the structure of power and authority in the classroom? Within the peer group, were there students whose esteem in the eyes of their peers was increased by their computer competence? Was the authority relationship between student and teacher affected by the presence of the computer?

Individual Teacher and Child. At the level of the individual teacher, there were many issues regarding professional role. Was the computer seen as a threat, as something which could displace or degrade the teacher's role? Did teachers feel in competition with the computer, itself a kind of "teacher" in the classroom?

Concerns about the teacher-student relationship, as well as about the teacher's autonomy, followed from studies of the effects of computers on professional roles. We wanted to know under what circumstances the computer interfered with teacher-student relationships and whether the presence of the computer and prescriptions for its use reduced the choices teachers could make about instruction for their students.

Many of these issues were, we assumed, related to the degree to which the teachers had adequate training and support to master the computer and to use it in ways consistent with their teaching and learning goals in the classroom. How much training and support was required to meet teachers' needs was of course, an important question.

At the level of the individual child, a central factor contributing to the educational impact of the computer, we assumed, was the way in which the computer was used in the

classroom. Here we were not interested in subject area, but rather in the kinds of interaction required and permitted. The possibilities range from drill and practice, requiring the least active engagement on the part of the child, to using the computational power of the computer to solve problems, to conducting simulations, to designing programs to teach something to other children, to teaching the computer itself (Licklider, 1979). While we wished to study what students learned as a result of different kinds of interaction with the computer, we were aware of the methodological limitations to doing so. Questions to teachers about what students learned were intended to shed light on these issues.

We had questions about the emotional and social consequences of computing. Do some children make gains in self-esteem and motivation associated with mastery of the computer, while others experience frustration and disappointment? Socially, computer competence could enhance a child's status in the peer group. Alternatively, socially isolated children could use the computer as a way further to isolate themselves from their peers. All of these possibilities were explored.

Research Design Overview

In order to investigate the many research questions which informed this study, case study methodology was used. Because case studies--intensive, independent analyses of particular situations--make use of information from a wide variety of sources to provide a comprehensive description of present conditions and their history, they are ideally suited to the multidisciplinary, exploratory nature of this investigation.

Case studies were compiled for three sites selected for their diversity. At each site, researchers collected information about each of the structural levels through interviews and classroom observations.

Information from each site was summarized, coded, and organized. At case study seminars, the research team synthesized and analyzed the information and identified the issues which emerged at each level at each site. Once all three case studies were completed, summarized and interpreted, the research team compared sites to analyze issues which were common and unique. This final report identifies issues of implementation and impact of microcomputers in education which warrant further study.

Site Selection and Sampling

Site Selection

A number of school systems were identified as potential sites because they had significant microcomputer use at both the elementary and secondary level. From these, three were selected because they differed significantly from each other and because they promised to be rich sources of data. The sites selected for intensive case studies were: a northeastern suburban community, which we shall call Greenview, a large midwestern city, to be called Granite, and a large southern city, to be called Salerno. These sites differed in several ways.

First, the sites were geographically diverse, representing three geographic areas in the country. Second, they were diverse in terms of population. Greenview was a primarily white, middle class community. On the other hand, Salerno had substantial black and hispanic populations, and served children in lower as well as middle socioeconomic groups. Granite also had minority populations (black, native American, Asian) and varied socioeconomic groups.

Third, these sites represented diverse uses of the computer. Among the three sites were included almost all of the uses and purposes of microcomputers in public education today.

All these sites had been previously involved with computer instruction via central computers. While sites were not selected on this basis, we found that sites making relatively extensive use of microcomputers had a history of using mainframes and terminals in instruction. This was true both of our candidate sites and of those we finally selected.

Sampling

Sampling for schools at each site was carried out in a manner that maximized diversity of information sources. In Greenview, because the system is relatively small we were able to visit every school which was using microcomputers. At the larger sites, however, we sampled from the many possibilities. Schools selected represented the variety of applications and populations in the district. Decisions about which schools to visit were made in cooperation with district personnel. Within schools, decisions about which teachers to interview were made in cooperation with principals or their designate.

We visited between seven and twelve schools at each site. In each school, we spoke with teachers who were centrally involved with the microcomputer program. When possible, we also spoke with teachers who were peripherally or not at all involved by choice or because of limited resources.

We observed formal classrooms in which microcomputers were being used, as well as libraries, resource centers and computer clubs. We interviewed students in each of these contexts.

At each site, we also interviewed district administrators, coordinators of computer education, as well as community persons. From the community, we spoke with school board members, parents, and other persons who played an active role in the use of microcomputers in the schools.

Data Collection

Summary

Information for the case studies was collected through interviews and observations as well as from newspaper reports and local documents about the use of microcomputers in schools. The major question of the study focussed on the interaction of the microcomputer and the social system, how this interaction developed over time, and how it may develop in the future. The data collection included the different structural levels within each community: the community, the school system, the school, the classroom and individual students and teachers. The emphasis was on both what happened in classrooms, and the social and political contexts that influence the classroom.

A three-member team, made up of researchers skilled in interviewing, classroom observation and assessment of instructional applications of computing jointly visited each site for a week. In addition, the principal investigator visited each site for a few days. During their visit, the team interviewed individuals who have taken an active role regarding the instructional use of microcomputers, and observed formal and informal contexts in which microcomputers were used. Individuals interviewed were selected to provide a diversity of opinions, points of view, and levels of involvement. Interviews were unscheduled, semi-structured and open-ended.

Methods

Community interviews. Individuals in the community who had played a role in the use of microcomputers in the schools were interviewed. This included members of the school board, parents of some of the students, members of Home and School Associations, community leaders, and employers. They were asked to describe factors which influenced recent school policy and how these factors affected the allocation and use of microcomputers. They also were asked about the role of individuals from the community in initiating, supporting and influencing decision-making on microcomputers in schools.

School system interviews. Central administrators--superintendents, assistant superintendents, and instructional coordinators (e.g., coordinators for computer instruction)-were interviewed. They were asked about the history and financing of the microcomputer program, how microcomputers are being used, what factors contribute to the differential involvement of schools and teachers, and the impact of the computers on administrators, teachers and students. In addition, they were asked about their expectations and hopes for the future of microcomputers in their system.

School interviews. School principals and assistant principals were asked about the history of microcomputers in their school, current funding and uses, provision for staff training, and their assessment of the effects of microcomputers. They were also asked to comment on future expectations and hopes.

Teacher interviews. Teachers were asked to describe their participation in planning for microcomputers, and the training and support they received. They were asked about their instructional goals for computer use, whether the computer is integrated into the curriculum in a way which is consistent with their views about teaching and learning, and whether the computer has changed their view of their professional role. They were asked whether there have been any changes in the classroom authority structure, and if there have been effects on other modes of instruction. They were asked to discuss the impact of the computer on social life in the classroom, as well as on individual students intellectually and emotionally.

Student interviews. Students were asked how the microcomputer is used in their class, who uses it, how they feel about working with it and whether they use it in other contexts. They were asked what they have learned about themselves and about school subjects through using computers, and what they see as the advantages and disadvantages of using computers for learning.

Classroom observations. Classrooms were observed to provide information about how computers were used, by whom, and for what purposes. The kind of interactions that are permitted and required, the diversity of applications in evidence, and the role of the teacher in the classroom were recorded, along with students' and teachers' level of involvement with microcomputers. To study issues of access, we recorded the number and type of students interacting with the computer, as well as assignment of students to particular uses of the computer. We also studied the teacher-student interaction and student-student interaction that occured. Any apparent hardware and

software problems and limitations were noted.

Research Procedures

Preparation: seminar. A research preparation seminar was conducted in advance of the pilot study. Each staff member was responsible for a portion of the seminar. The group studied a glossary of computer terms and discussed in particular those terms with ambiguous meaning, such as computer-assisted instruction. It was noted that these terms would require clarification during interviews. The political and interpersonal issues involved in entering and visiting school systems were discussed. Strategies were suggested for making site visits as smooth as possible.

The staff reviewed observation techniques which varied from descriptive to inferential. Placing our techniques on the more descriptive end of the continuum, we discussed the kinds of inferences which could legitimately be made on the basis of these observations. We also discussed those variables which are most appropriately studied through classroom observations. The observation form was revised.

We outlined the strengths and pitfalls of open-ended, unstructured interviewing, and reviewed in detail the many issues which interviewers must keep in mind. A teacher interview was then role played and discussed. The interview guides were revised and detailed plans were made for the pilot site visit.

Preparation: pilot study. A two-day pilot study was carried out in a New York suburban community which uses microcomputers extensively. We interviewed a district administrator, computer coordinator, and two principals (elementary and junior high school). We also interviewed teachers and observed classrooms in elementary, junior high and high schools. We interviewed elementary and junior high students as well.

Following the visit, we made some changes in our observations and interview procedures. We conducted a case analysis seminar, identifying the problems and issues which characterized the pilot site. A case outline was prepared, which was then used to organize and summarize information from each research site in the main study. On the whole, our data collection methods were comprehensive and effective for obtaining the information we needed.

Methods of informing and securing permission. Prior to contract award, each site had been contacted and letters of interest solicited. After receipt of the NIE contract, each site was contacted again, and given more specifics about the project. Permission was then obtained in a site-specific manner. In Greenview, permission was

obtained through the coordinator of computer instruction. Subsequent to this the two district assistant superintendents met with the principal investigator to clarify procedures and finalize plans for the site visit.

In Granite, permission was obtained to visit two schools which had what we considered interesting computer applications. Subsequently, we were put in touch with a school system mathematics consultant who facilitated our visit, arranged for meetings with district administrators, and provided us with names of all of the schools using microcomputers in Granite. The research team then arranged details of school entry, data collection, and scheduling for all the selected Granite schools.

In Salerno, permission was obtained through district administrators. Instructional Computing personnel worked out the details of school entry and scheduling.

Confidentiality of information. The names of the sites have been changed, to keep their identity confidential. It is possible, however, that experts in the field will recognize the sites. Although no names are used, it is also possible that some individuals may recognize themselves (or others) in reports. All participants had the option of giving us information to be used for background purposes only (i.e., complete anonymity) if they wished. At the beginning of each interview, participants were informed of the purpose of the study and that the information they provided would be confidential.

Participants at each site had the opportunity to review and comment on a draft of the case study of their site. Although participants did not have the right to censor what was written, they could correct inaccuracies and further strengthen the disguises of some individuals, if that seemed warranted.

On-site data collection procedures. Before arriving at a site, the research team arranged with school system personnel which schools were to be visited, and scheduled classroom observations and interviews with some teachers and the principals. In addition, they scheduled interviews with district administrators, and some school board and other community members. Time was left in the schedule so that researchers could follow up on leads which developed while they were at the site.

All members of the research team were trained to conduct every type of data collection in the research plan. This maximized the flexibility of the team at each site. One team member was in charge of scheduling and task assignment at each site.

For classroom observations, we observed for a minimum of 20 minutes and then spent the remainder of the class period interviewing students. The observation and student interview session was usually followed by an interview with the teacher, on the assumption that the teacher interview would provide more insight if it followed the classroom observation.

Researchers made notes as they interviewed and observed. Important information, however, was often obtained through informal observations and talks in hallways or during a meal. Under these circumstances, notes were made as soon as possible after obtaining such information.

In the evenings, researchers met and, using the case outline for a guide, filled in as much information as they could about the site. In this way, information gaps were identified and plans were made to collect missing information while still on site. When necessary, participants were phoned after the site visit to clarify information or to provide additional detail.

Analyzing, Synthesizing and Reporting the Data

Immediately after a site visit, each member of the research team:

1. Filled in details which may not have been recorded at the time of an interview or observation.

2. Summarized each interview and observation in a brief statement of one or two paragraphs.

3. Cross-referenced notes with the case outline.

4. Wrote a summary of the problems identified by participants at the site, the issues which the researcher inferred from the information, and the characteristics which appeared unique or particularly critical to the computer implementation at that site.

A two-day case analysis seminar was held during the week following each site visit. Staff members reviewed the data in advance of the seminar. The purpose of the seminar was to complete a preliminary version of the case outline. This required filling in the information and descriptive parts of the outline (or at least indicating where the information could be found). More importantly, it required the research team to explain tentatively the critical features of the implementation, and the issues at each level of organization. This necessitated careful examination of the data in the light of alternative interpretations.

Case Outline

As previously stated, the case outline was developed during a case analysis seminar which followed our pilot study. It grew out of extensive discussion about the information and interpretation to be recorded for each site, and about the best way of organizing it. The case outline, therefore, was used to guide both the synthesis and organization of data, as well as the written report of each case.

Draft Case Reports

When consensus was reached during case seminars on the interpretation and description of a given site, researchers immediately wrote those sections of the case reports. When questions were raised, or when there were disagreements in interpretation which required more careful examination of the data, researchers reviewed the evidence and then met to rewrite those sections or issues that were in dispute.

A complete draft of the case was then written and edited. Copies were sent to participants at the site for comment. After comments and suggestions were received from participants at the sites, final drafts of the case studies were prepared.

When the three case studies were completed, the research team compared the issues that emerged at each organizational level at each site. This kind of examination provided insights into why some issues were salient in particular contexts, while others appeared universal. From our multidisciplinary perspectives, we identified those issues which we believe to be the most central to the future study of microcomputers in education. These issues are detailed in chapter five.

CHAPTER TWO

SALERNO

Introduction

Salerno presents a model of an innovation in which authority and resources are centralized. It is a carefully planned innovation, with explicit curricular goals. Microcomputer use in primary schools takes place primarily outside the classroom, and in this sense is peripheral to ongoing classroom life. What is unique about the Salerno innovation is its potential size and scope, represented most vividly by the large investment of district resources in software production.

Description of Community

Salerno is a major metropolitan center in the South. The city, with a population of approximately 800,000, is in a metropolitan area of approximately 1.5 million. Important businesses include insurance firms, banking and technology. The wealthiest residents are clustered in several prestigious suburbs, leaving a city population of primarily middle income and low income residents. The population includes anglo-American, black and hispanic residents.

In the last few years, there has been a relatively large influx of non-English speaking immigrants. The city and surrounding area has grown enormously in the last 10-15 years.

Salerno School District

The 180 schools in the Salerno system serve 122,000 students. The school population is approximately 35 percent anglo-American, 45 percent black, and 20 percent hispanic. There are 138 neighborhood primary schools (kindergarten through third grade) and/or intermediate schools (grades 4 through 6), 23 middle schools (grades 7 and 8), and 40 senior high schools (grades 9 through 12).

The school system is currently making the transition from one superintendent to another. The previous superintendent was a dynamic, aggressive futurist, enamoured with educational innovation. Under his leadership, the Development Division of the school district grew rapidly. This division now employs almost 400 people and has a budget of over $9,000,000. The responsibilities of this division include promoting curricular innovations, evaluating educational programs, and obtaining funds from government agencies to finance these educational experiments. The present superintendent is primarily concerned with supporting the instructional program,

emphasizing teaching basic skills to all students. He plans to give priority to programs that have direct consequences for classroom teachers.

The central administration of the Salerno School District is headed by the Superintendent of Schools and five associate superintendents. The district is divided geographically into six regions. Principals report to their regional administrator, and regional administrators report to the Associate Superintendent for Learning. This associate superintendent also supervises the district's subject matter specialists, including the coordinators for reading and mathematics instruction. Curriculum Development is located in a separate division, under the Associate Superintendent for Development.

Recent Developments Regarding Schools

1. Low performance on standardized tests

Three years ago, the state conducted a statewide assessment of mathematics skills among fifth, seventh, and ninth graders. Students in Salerno scored among the lowest in the state, and also scored low on other achievement measures. Nationally normed standardized tests, administered yearly by the school district, show that while students in grades 1 through 3 score just slightly below the national norms, by the time they are in grades 9 through 11 they score in the bottom fourth of pupils nationwide. The week we visited Salerno, the local papers had front-page headlines about the spring, 1980, test results. Scores increased this year, but were still below average. An editorial optimistically summarized the results of the recent testing:

> "Test scores reported this week are the best in eleven years, according to school officials. Comparisons with scores of the past two years also seem to reveal success with the [district's] new programs to stress the education fundamentals of reading, writing, and mathematics...Test scores in most categories are below national averages but are above norms for some comparative big-city school districts."

In a statement of goals for the 80's, the very first goal of the Salerno School District is raising test scores by at least 5 percentile points each year.

2. Emphasis on standardized tests as measures of effective education.

The Salerno School District has a history of using commercially produced, nationally normed standardized tests

to document school effectiveness. Recently, two other standardized tests have been developed by the state and the district to help in promoting educational standards. The state gives fifth, seventh, and ninth graders tests of basic skills and the district requires that high school students pass tests in reading and mathematics to receive a literacy certification on their diploma. The present superintendent has stated that, starting in 1983, test scores will be used in evaluating principals and teachers.

3. State curriculum mandates

The state is becoming increasingly prescriptive about the content of the curriculum. For some time there has been a list of state-approved text books. A statewide study was recently conducted to assess students' math achievement. As a result, the state has placed more emphasis on baseline objectives in mathematics.

4. Court-ordered desegregation

Approximately 10 years ago, the city was ordered by the courts to provide a school desegregation plan. The federal district judge proposed an extensive bussing plan involving 7,000 students. This plan was appealed and, four years later, the circuit court ordered the judge to develop a new plan. In 1976 the new plan went into effect. Students in intermediate schools and middle schools are bussed (grades 4-8). The primary schools remain neighborhood schools, and the high schools remain regional.

As a result of the desegregation mandate, many middle-class families moved to the suburbs or enrolled their children in private schools. Enrollment in city schools dropped by 30,000 students from 1970-1980, and the proportion of anglo-American students went from 69 percent to 32 percent. The desegregation plan is still in the courts, having been appealed by the NAACP five months after it went into effect.

5. History of educational innovation

The former superintendent of schools, in office for 10 years, was enthusiastic about innovation and actively encouraged many experiments in the schools. Many teachers now feel that they were so busy adapting to proposed changes that they had little opportunity to develop and refine their teaching techniques. They are eager to get "back to the basics" - to traditional didactic teaching of basic skills. The teachers are critical toward innovation and feel it has undermined quality education.

6. Size of central administration

Under the former superintendent, the central administration became quite large, with many special departments to support experimental programs. How this legacy of an extensive bureaucracy will be used by the current superintendent remains to be seen. He feels the district is top-heavy with administrators, and that too many resources go to departments that have no direct impact on the classroom..

Use, Number, and Distribution of Microcomputers

The school system presently owns 300 16K Radio Shack TRS-80's (Model I) which were purchased through Title I money and state compensatory education funds. These microcomputers are located in over 60 schools, including fifteen Title I primary schools and twenty-three middle schools (grades 7 and 8). Three hundred more TRS-80's (Model III) are on order and most of them are targeted for use in the intermediate schools (grades 4-6).

The microcomputers in the primary and middle schools are all used for remediation in math. The software was produced by the district. The entire K-8 computational curriculum is sequenced and students are assigned to drill on a skill at a level chosen by their classroom teacher or by a Title I teacher.

In many schools, microcomputers ("micros") are located in a resource room, where students work with them for about 50 minutes a week. It is recommended that each student use the micro 10 minutes every day, but in some schools this is modified to 50 minute sessions once a week. The students' work with the micro is typically monitored by aides, who are also familiar with several kinds of equipment used for math remediation.

Last year, 50 Apple computers were put into five high schools in a pilot program for computer literacy (programming). This year, 76 more micros, TRS-80's this time, will be distributed to the high schools as part of the computer literacy program.

Support for Computing

When the school district began considering the use of micros for instruction, no software was available to meet its needs. The Department of Instructional Computing within the Division of Development was charged with developing locally appropriate software. They decided to develop full curricula rather than a number of discrete, unrelated lessons. They planned to create integrated curricula for mathematics, reading, and language arts. The microcomputer was to have a supportive role, providing practice in skills that were originally taught by the

classroom teacher.

Last year, the Instructional Computing Department (ICD) had a budget of almost $600,000 with approximately 60 percent from the district budget and 40 percent from federal funds. The ICD employs 24 people: fourteen curriculum developers and ten programmers. The ICD staff feels that the costs for software development are reasonable because the software will be usable for many years and because micros are expected to replace paraprofessional tutors.

A drill and practice mathematics curriculum in basic computational skills for grades K through 8 has been developed and is now in use in the district schools. Its use is restricted to students who perform below grade level because the microcomputers were purchased through state and federal compensatory education funds.

Implementation of the computer-based mathematics curriculum, as well as computer courses in the high schools, is under the auspices of the district's mathematics coordinator. There is an implementation council which decides on staff development. Although the ICD developed the software, it has only minimal connection with the implementation of the mathematics curriculum. One person from the department worked with the staff of the district math coordinator to write an implementation guide.

The math coordinator placed the micros in schools where there was at least one aide or teacher who was willing to learn how to use them. Last year the micros were specified as an essential component of the Title I math program. Consequently, they were placed in the primary schools with Title I math programs.

The ICD is developing additional mathematics curricula as well as new curricula in reading. Two projects are funded by the district, and two by federally-sponsored Title IV-C. The district coordinator for reading has kept informed of the development of the reading curricula. He is to direct their implementation in the schools, playing a role similar to that of the mathematics coordinator.

The subject-matter coordinators with responsibility for implementing the microcomputer programs are located in the Learning Division, while curriculum development occurs in the Development Division. Working relationships between these units are minimal. Instructional specialists are invited to meetings to discuss general plans for the computer-based curricula. However, these specialists do not participate in specifying objectives for each lesson or in sequencing lessons in the curriculum. When the software is used in classrooms there is only a weak mechanism for systematic feedback from the users to the developers.

The previous superintendent envisioned recouping development costs by marketing district curricula. He created a foundation to handle the marketing, along with other income-managing functions. This foundation was disbanded for many reasons, among which was concern over whether a public school district should compete with private businesses. Alternatives for dissemination are now being explored, including the possibility of selling the materials to a publisher and collecting royalties.

History and Current Organization of Computing in the District

Before Microcomputers

Computing has been a part of the Salerno curriculum since 1965. A three-year grant from the National Science Foundation provided General Electric time-sharing terminals in the high schools for programming and computer math. In 1968, the school district set up its own computer center, adding terminals in the junior highs. The present programming curriculum is supervised by a district mathematics coordinator who formerly taught programming at one of the high schools.

Computer-managed instruction began five years ago. Under a Title VII contract the district developed a bilingual program that incorporated a voice synthesizer to teach Spanish and English to Spanish-dominant children. It was designed to supplement the classroom curriculum. The program was first used in 1977 and is still in use today, running on a minicomputer. Students spend 10 minutes a day doing individualized drills in reading and math. The computer also keeps records of student performance. Program developers are considering adapting this program for use on a micro.

In three district schools, terminals are used by all students for drill and practice in mathematics and language arts. The district purchased a computer-managed instructional program which is run on a Hewlett Packard computer. This system initially cost about a half million dollars and costs $40,000 yearly to administer. The program is diagnostic and prescriptive, assessing students' skills, presenting items at a level of difficulty appropriate for each student, and keeping records of students' performance.

This computer-managed curriculum is also used in a special program for deaf children. The teachers there are very enthusiastic about the effects of computer-based instruction for deaf children. The resource room teacher reported that the students' achievement with the computer is typically higher than in their regular classroom work.

She proposed that this is because language limitations are minimized with the computer.

Introduction of Microcomputers

Software acquisition and development. In order to create the needed software, a significant amount of instructional development had to occur within the ICD. First, the decision was made to focus on the basic computational skills. Then, all objectives of the computational mathematics curriculum had to be stated specifically and appropriate lessons created. The lessons had to be organized hierarchially so that teachers could decide where students should begin.

With the development of this mathematics curriculum, a general model for instructional design evolved. At first, instructional specialists in mathematics wrote the specifications for a lesson, and then consultants programmed the lessons. The designers were disappointed with the resulting software. They realized that they had many assumptions about features of the lessons that were not made explicit to the programmers. The ICD decided to have in-house programmers so there could be on-going interaction between the curriculum writers and the programmers. In this way, programmers could become increasingly sophisticated about the assumptions of the designers, and the designers could develop expertise about what could be programmed.

The leaders in the ICD emphasize that they are curriculum developers, not computer scientists. They feel that when hardware limitations make it impossible to produce educationally adequate lessons for a particular subject then it should not be included in a computer-based curriculum. They have tabled a computer-based writing curriculum because of what is, in their view, inadequate technology.

The ICD is currently developing four different curricula for microcomputers. Two are funded from district funds, and two are funded through Title IV-C. The district-sponsored curricula address basic skills in math and reading. This year, lessons in ratio, proportion, and percent will be written and pilot tested. Lessons in multiplication and addition facts for grade levels K-8 will be revised.

The basic skills drill and practice project in reading was initiated two years ago. It covers the reading skills taught in grades one to three, but is designed to hold the interest of fourth to sixth graders. The lessons make use of color and voice, and are designed for the Texas Instruments 99/4 microcomputer with voice capability. The

lesson writers are former classroom teachers who learned about programming through an NSF-sponsored course at a nearby university. This reading curriculum is to be used in labs or resource rooms, with six to eight micros under the supervision of a proctor. Pilot testing of some of these lessons will occur this spring.

The curricula funded through Title IV-C address higher-level skills in mathematics and reading. The lessons are targeted for grades 4-6 and are on grade level, rather than remedial. The reading curriculum is in the second year of development. Close to six months was spent identifying objectives and sequencing them in a learning hierarchy. The curriculum focuses on skill areas where Salerno students performed substantially below average on standardized tests. After identifying these areas, the developers examined state-approved textbooks and found that few, if any, lessons even referred to these skill areas. They designed the computer-based curriculum to help teachers teach for objectives that are not included in the reading textbooks but are tested for on standardized tests.

The computer-based lessons in higher-level reading skills will be used differently from those in the remedial mathematics curriculum because they include instructional material as well as provide practice opportunities. Some of the lessons in the reading curriculum will be field tested this spring.

Use, values, intent. The mathematics curriculum is a sequenced set of practice items. There is not an instructional component to explain how to do a problem or why a particular answer is wrong. The program is to be used by students who have already had instruction. The computer-based practice provides opportunities to use a new skill under conditions of immediate feedback. If a student answers incorrectly, it is assumed that the student has enough resources to correct the mistake.

This instructional tool is for students who are below grade level. Students are assigned to use the machines on the basis of standardized tests administered early in the fall or the previous spring. The goal of the program, as described by an aide, is to "bring these students up to grade level as fast as possible."

The use of the higher-level reading curriculum may be quite different from the drill and practice mathematics lessons because they include instructional components. Exactly how this curriculum will be used remains to be worked out.

Primary Level

Features of the Microcomputer Program

Demographics and personnel. The research team visited three of the fifteen primary schools using micros; all were neighborhood schools. Some were surrounded by relatively new single-family homes; others were in low-income housing projects. Despite the differences in the neighborhoods, the schools and the role of the microcomputers seemed very similar.

These were generally open-space schools, with areas marked off by movable partitions. In all of the schools micros were part of a Title I program. Last year, district policy specified that all Title I children were to use the microcomputer, but this year practice with the micros is at the discretion of the teachers. The micros were located in a resource area, and were supervised by an aide who helped students with the machine and kept records of the lessons completed each day. The micros were one of several pieces of equipment in the resource area. The Title I teacher decided which students were to work with which type of instructional material.

Training/support. Before school began in the fall, the Title I teachers and aides attended a workshop on how to use the micros. They learned to load and run a program, became familiar with how students were to enter responses, and learned how to select the number of practice problems the student would complete. Aides were also introduced to a record keeping system that documented the lessons students completed.

Apart from the workshop, teachers and aides did not receive additional training, nor did they report that they needed more training. Most seemed comfortable with the tool. If a teacher or aide wants to learn more, they can take free courses in programming from Radio Shack during the summer.

Equipment. Primary schools had 4 - 12 micros, all TRS-80's (Model I) with cassette recorders.

Resource distribution. Micros were distributed to Title I schools based on a district-adopted ratio of students per micro. The classroom teacher and/or the Title I teacher identifies children who are below grade level in their math computational skills and can profit from working with micros. Students assigned to the micro typically spend 10 minutes a day with sequenced lessons. Children receive other remedial instruction as well, and some students do not use the computer at all because other materials or techniques are judged more appropriate. We observed 15 boys and 10 girls using microcomputers in elementary schools' resource rooms.

Purpose and relation to the curriculum. In a general way,

the software is directly related to the curriculum because the same baseline objectives guided the development of the software and defined the primary math curriculum. However, the relationship between the computer-based instruction and the students' daily classroom instruction can be remote. Long time periods may elapse between the introduction of a concept in the classroom and the student's practice on the micro. In some cases, we were told, students practiced on concepts which had not yet been introduced.

Effects and Problems: Administrators

Principals have a minimal role to play in the microcomputer implementation. When the Title I program specified the use of microcomputers for instruction, principals felt they had little or no choice about using them. In addition, Title I teachers and aides are hired and assigned to schools by the district. They are not under the direct supervision of building principals.

Looking to the future. School administrators hoped that in the future microcomputers would be in all classrooms. They wanted broader uses of the computers, for a wider range of children and curricular areas. One felt, however, that the computers would continue to be limited to math for some time, because of the lack of software in other areas. One administrator looked forward to a future in which she could use micros for administrative record keeping.

Effects and Problems: Teachers and Aides

Effects. One teacher felt that the correspondence of the microcomputer mathematics lessons to the district math program, facilitated teacher planning. Teachers commented that with the machine reinforcing students' skills, they have more time for instruction. With some children at the micro, they have smaller groups to work with. One noted that observing students while they solved problems on the micro helped her to diagnose student weaknesses or misunderstandings.

Problems. Last year all students enrolled in a Title I program were required to use the micro. Although teachers felt this activity was not appropriate for some students, teachers were not permitted to exercise judgment on the matter.

Teachers and aides reported that because tapes took a long time to load, they typically loaded one tape in the morning and used it all day.

Looking to the future. Several teachers and aides expressed the hope and/or expectation that microcomputers would be in all classrooms in the future and that all

teachers would learn how to use them. Yet there were some doubts about the future. One remedial teacher felt that continued use of the micros should depend on positive outcomes, while another felt that future government funding was in doubt.

Effects and Problems: Students

Effects. An administrator observed that many children developed more independence in learning as a result of using micros, and that children experience feelings of completion and success. The administrator felt that the fast feedback is important for promoting learning. The parents are impressed that their children are using computers.

One teacher commented on the lack of discipline problems when students are using the micros. One administrator was skeptical of the effects and suggested conducting a controlled study.

Problems. Several members of the teaching staff felt that the micro was more appropriate for second and third graders than for first graders, because some reading competence was required. One teacher felt first graders needed more personal teaching than the computer affords.

An administrator also felt that younger children are less likely to profit from working with micros. She proposed that they were intimidated by the hardware, and recommended that these children be introduced to the micros gradually. This administrator also noted that the keyboard is difficult for many students and suggested that keys be placed in alphabetical order.

Not all Title I children can use the micro because of the large number of eligible children. In addition, children not in Title I do not have access to the machine, though parents are requesting this opportunity.

One software problem is that students cannot change their answers. If they inadvertently hit a wrong key, the response cannot be erased; it counts as an error.

Secondary Level: Middle Schools

Features of the Microcomputer Program

Demographics and personnel. In the middle schools (grades seven and eight), students are bussed to meet the specifications of the court desegregation order. Some are magnet schools, with a special emphasis in some curricular area, while others are general schools. The research team visited three of the twenty-three middle schools that are

using micros.

There were different arrangements for using the micros. In one school, two or three micros were in each of two mathematics classrooms, and the teachers incorporated the micros into the daily lessons. In another, the micros were located in a resource room staffed by a math aide, and students were sent to the room for one period a week. In the third, a mathematics resource teacher staffed a math enrichment room, which housed many different kinds of materials for individualizing instruction, including micros.

Training/support. In the fall of 1979, when micros were placed in schools, teachers and aides received fourteen hours of instruction in how to operate the micros and in the scope and sequence of the computer-based curriculum. record keeping forms were introduced, and guidelines for machine use were presented. Teachers wanting more advanced training attended a 21-hour course at local Radio Shack Centers. This year, the district held a two-day workshop to review the use of the micros and introduce new staff to the micros. Teachers and aides from the middle schools felt that their training was adequate. They were comfortable and enthusiastic about using this tool.

Principals played a supportive role in all schools we visited. They respected the recommendations of teachers and responded when asked for help in planning and staffing for micros.

Equipment. All microcomputers were TRS-80, Model I, with cassette recorders.

Resource distribution. The schools that received micros from the district had a staff member, either a teacher or an aide, who was willing to attend the training workshop. Generally, the school received five micros for each teacher or aide who attended the workshop. One middle school also purchased 2 TRS-80's with funds from the math department and the PTA.

Each individual teacher or math department decided on how to assign students time on the machine. Because the machines were purchased out of state compensatory education funds, only students who were below grade level were allowed to use the machine. When the machines were located in a classroom, teachers typically assigned students 10-15 minutes machine time each day. When the machines were located in a resource room, students used micros one class period per week. In the math enrichment room, students needing drill on the problems that were loaded that day used the machine. In all schools, students worked individually and asked the teacher for help if they needed

it.

In the two schools where micros were not in classrooms, they were shared by the entire math department. The department, therefore, had to develop rules for access. While rules differed slightly, access was limited to students who were considerably below grade level. We observed 15 boys and 11 girls using microcomputers in seventh and eighth grades in Salerno.

Purpose and relation to curriculum. Because the software was created from baseline objectives that were used throughout the district, the relationsip between software and curriculum was generally very close. However, the match between software and curriculum at the day-to-day level depended on where the machines were located. When the teacher had the micros in the classrooms, drill and practice could be selected that fit in with the day's lesson.

In one class we observed, for example, the teacher explained how to determine whether a fraction is proper or improper and then sent students to the computers to practice this concept. While three students worked at the computers, others did exercises in their books. We did notice, however, a slight problem. In the computer program, the term "proper fraction" applied to any fraction in lowest terms. For example, 31/4 was labeled a proper fraction by the computer program. The teacher, however, considered this an improper fraction that could be reduced to 7 and 3/4. The teacher had to point out this inconsistency to the students in the class.

When the computers were located in a resource room, the relationship between the drill on the computer and the day-to-day class work was less direct. Teachers specified an area that each student should practice, and the aide arranged to have an appropriate program available. However, it was not necessarily the area that was being taught in class. The aide selected a level at which the student could answer at least 80 percent correctly, and then presented sequentially more difficult lessons. If the student scored less than 80 percent, the aide asked if he or she understood how to do the problems and would like to try again. If the student needed an explanation of how to do the problem, the aide would provide it. Usually students volunteered to try again.

The aide kept records of the lessons students attempted and of the percent of questions answered correctly. These records were sent to the teachers at the end of a 6-week session. This was the only procedure for informing teachers of what and how their students had been doing in the resource room.

Effects and Problems: Administrators

Effects. Principals said it was too early to identify effects of the microcomputer on student achievement. They did not, however, expect teachers' roles to change substantially with the use of micros. One principal felt he would be evaluated on increases in his school's math scores. He was eager, therefore, to use anything that might help raise scores.

Problems. One principal noted that the microcomputer program was costly, and wondered if using it for remediation justified the expense. He suggested that using computers for enrichment might be more justifiable.

Looking to the future. Middle school administrators questioned the future use of micros in their schools. One felt that the high cost would make for very few new developments in the near future. Another disagreed, feeling that costs were becoming low enough that expense would not be an issue. He felt, however, that how the machines should be used was an issue. He hoped they would be used to enrich curriculum in all areas, as well as for administrative purposes.

Effects and Problems: Teachers and Aides

Effects. One teacher enthusiastically used micros in her classroom. She reported that she had more time to work with students individually when some were using the micros. An aide also reported that she could help more students when there were micros than she could as a tutor. She felt that there were no discipline problems when micros were used.

Problems. Teachers using the computer-based curriculum reported that they spent more time planning and organizing for individualization. Because of this, one teacher recommended that the micros be placed in a resource room supervised by an aide. Several teachers reportedly were uninterested in having micros in their classrooms.

Another teacher, new to the school system and to the microcomputer program, had difficulty choosing appropriate lessons for students. Students in his class typically got all or most of the problems wrong. The teacher merely encouraged them to try again. This resulted in increased confusion about the mathematical operations they were trying to master. When a student scored 70 - 80 percent correct, the teacher felt the program was "too easy" and chose another, more difficult lesson in the sequence.

As at the primary level, loading programs from tape limited

use of the machine. Because of the long loading time, teachers and aides would load the machines in the morning and then use those programs throughout the day. If the programs were too difficult for a student, he or she would not work with the computer for that day.

Looking to the future. Secondary teachers did not, in general, comment on the future. One teacher wanted more microcomputers in the future, and increased staff development possibilities. She hoped that teachers would learn to program. Another wanted software to teach students how to solve word problems so that they could do better on standardized tests.

Effects and Problems: Students

Effects. The middle school students' attitudes toward the computer varied widely. Some seemed bored or even resistant, others seemed interested and eager. One student remarked "It's better than doing problems on paper." Many students did extra work on the machine before school or at lunch hour.

One aide reported that several students had made remarkable progress working with the micros. She described one girl for whom the teachers had low expectations. As a result she did little work. She was, however, self motivated. With the micro, which didn't have any particular expectations, she could take initiative and accomplish as much as she was motivated to do.

Teachers felt that the computer increased students' attention span - particularly for students mainstreamed from special education classes. One principal questioned whether this would wear off after a while.

The hoped-for effect is to get students up to grade level as fast as possible. An enrichment teacher pointed out that many students develop incorrect strategies for solving problems. She hoped the computer would be effective in helping students to unlearn these behaviors because it presented problems step-by-step.

Another teacher suggested that some students may have difficulty working with an adult. Practicing alone with a computer may be motivating for these students.

Problems. Because students work individually at the computer, social skills were not enhanced at the computer. Even when children encountered problems, those we observed used only minimal language in explaining the problem to the teacher or the aide.

There were some software glitches. Answers that were

correct were sometimes labelled "wrong" by the machine. Some students were challenged to find these errors. Others, however, seemed to lose confidence in their own ability when they responded with a correct answer and the computer told them it was incorrect.

One teacher felt that there was a stigma associated with using computers because they were used only for remediation. He refused to have them in his classroom.

Students were frustrated when they made an accidental error because there was no way to revise their answer. The computer immediacely counted it wrong.

One teacher was concerned that using the computer was producing students who have a very positive view of their skills, but unrealistically low standards for their performance. Because students drill at levels where they answer 80 percent of the problems correctly, they become more confident. Unfortunately the level at which many of the students are performing is still substantially below grade.

Secondary Level: High School

Features of the Microcomputer Prog[illegible]

Demographics and personnel. The research team visited one of the five high schools that received district-purchased Apple computers for a pilot project on computer literacy.

One math teacher uses micros and terminals to teach computer math, computer literacy, and programming. None of the other math teachers seems interested in using micros. It was proposed that this lack of interest was due to the extra work and teacher involvement required with micros. Teachers would not be able to grade papers during a class period because they would be answering students' questions.

Training/support. The math teacher who is using micros learned the basics of programming from the previous computer teacher. She is also taking computing courses at a nearby university..

Equipment. There are 13 micros - nine TRS-80's, three Apples, and one Texas Instruments 99/4- in two small rooms. One of the rooms also serves as a classroom.

Resource distribution. Courses with computers are offered as math electives. Generally, only seniors are enrolled because they register first and usually fill the class. Students who are good in math take these electives. In the one class we observed, no minority students were enrolled. (The enrollment of the school is 5% minority.)

Purpose and relation to the curriculum. Skills in programming and understanding the uses of computers are seen as legitimate topics for courses. The teacher integrates the computer into each course as she sees fit.

Source and use of software. The software for programming was part of the package that came with the microcomputer from each distributor. The teacher also obtained some extra software from Apple to use in her computer literacy classes.

Effects and Problems: Teacher

Problems. It was reported that the use of micros results in more work for teachers. Students have many questions about the machines and programs. Teachers must make time to respond to each individually.

Looking to the future. This teacher has an extensive vision of the future of microcomputers in Salerno schools. She feels that the machines will revolutionize education. Because of micros, texts will be rewritten and teaching restructured. Students' reading skills, attendance and "precision" will improve. In addition, she thinks that students will become more logical and disciplined as they have more opportunities to interact with microcomputers.

Effects and Problems: Students

Effects: Girls are becoming increasingly interested in learning about computers. They comprise 33 - 50 percent of students in the elective computer courses. In the class we observed 10 of the 27 students were female.

Problems: Computing electives are available only to relatively good senior year math students.

District Level

Effects and Problems: District Administrators

Effects. In Salerno most of the administrators we spoke with had roles directly connected with technology, its development and/or implementation. The microcomputer implementation had a critical effect on their roles. In some cases their very positions would not exist without the microcomputer activities.

These administrators report that microcomputers have impressive effects on students, although admitting there are no definitive data. Yet the feeling is that the current program is motivating students and helping with basic skills improvement.

Problems. Not all administrators are convinced that software development is an appropriate activity of the school district. Some feel it might be more appropriate to purchase software from publishers, and thus avoid the development costs. Some, on the other hand, feel that Salerno is on the cutting edge of technology in education, has an outstanding track record, and should both continue and expand its development efforts.

There is some uncertainty about the commitment of the new superintendent to development efforts. With budgets being scrutinized and cut, administrators are uncertain of the level of support to expect in the future.

Administrators directly connected with implementation are concerned that school administrators become computer literate. Moreover, there is a fear, already warranted in some cases, that teachers who master the computer will leave the schools for better paying jobs in industry.

Looking to the future. Some administrators expressed hopes for more resources--a micro in every classroom, more extensive software--as well as more hands-on teacher training. Others had a more radical view of the changes the technology-rich future would bring to the Salerno school system. The administrators of the ICD envisioned extensive changes resulting from the use of microcomputers. They predicted that differentiated staffing in the schools would evolve in 5-10 years. Master teachers will function as diagnosticians and managers of instruction. They will be supplemented by personnel who monitor drill and practice and aides who do one-to-one or small group tutoring. For teachers this will mean fewer positions and changed roles.

The ICD predicted that in five years remedial math programs will be in all schools and the remedial reading program will be in 1/3 to 1/2 of the schools. They stated that these programs will be supported by external funds for remedial programs. There is a question, however, of how extensively the reading and mathematics programs targeted for grades four through six will be used unless outside funds become available.

Another revolutionary scenario envisioned by a district administrator combined micros with two-way cable TV and videodisk. According to him, technology could deliver most instruction, while teachers add the human and social dimension to schooling. The problem with this vision is that it is very expensive, both for equipment and development. He felt that since the school district has a proven record of development, the community may continue to invest in this activity.

Issues from Salerno

There are many issues raised by the microcomputer implementation in Salerno. Those that are most central are discussed here.

1. Is software development an appropriate function of a public school district? Many individuals in the school district are struggling with this question. While they realize that there is no commercial software that meets their needs, they question whether the budget for the development of software is merited. The ICD projects that the costs will be offset by hiring fewer paraprofessionals to tutor remedial students. One way to partially finance development would be to market the software. However, commercial marketing is strongly opposed by some members of the Board of Education.

2. Who has the responsibility for evaluating microcomputer-based instruction? When micros are used outside of the classroom, and their use supervised by someone other than the classroom teacher, the teacher has difficulty evaluating their effectiveness. The non-computerized curriculum is under the control of the teacher, although designed by others, and the teacher interacts directly with it. Because the teacher is the direct user, he/she can evaluate its effectiveness. In the future, the Research and Evaluation Department might conduct a formal evaluation of the microcomputer program. However, this Department has not worked closely with ICD in the past.

3. Will the comprehensive software package currently used limit the district's choices in future microcomputer purchases? The program is designed to capitalize on the current hardware. With rapid developments in microcomputer technology, however, micros will soon have many new features. Will it be relatively easy to modify current software to capitalize on future capabilities of micros, or will difficulties with revising software limit buying to machines of 1980 vintage? The district is already facing this problem because the mathematics materials were written for a TRS-80, Model I, but the district recently purchased TRS-80, Model III's. The ICD is exploring how the software can be revised for the new machines.

4. Software developers are lacking information on design features of instructional software. Those developing instructional programs in Salerno have many questions about the specifics of design: Should students get more than one chance to answer a question? How many practice examples are enough? How long should the program wait before going on if the student has not responded? Having carefully

reviewed the available research, they find it inadequate. Moreover, the developers cannot conduct their own research. The conditions under which the instructional programs are used are not suitable for the systematic study of instructional design. Exposure to micros is just one component of a complex instructional system, and the effects of particular features of the micro program would be very difficult to isolate.

5. Would involving teachers and curriculum specialists in the development of software facilitate implementation? The ICD is isolated from the Learning Division. An entire software package is developed before it is used in the schools. Field testing usually focusses on programming problems rather than curriculum questions. If teachers do have suggestions for improving the match between their teaching and the software, it is often too late and too expensive to modify a program when it is so close to its final form. The Learning Division trains teachers to use the software packages. The extent to which their training matches the expectations of the software writers may depend on their involvement in software development.

6. Is additional staff needed to manage machine use? Several teachers in Salerno commented on the individualization that the machine fosters. Individualization takes many forms. Because students work on different lessons, procedures are needed to assign students to lessons, to keep track of their progress and to answer their questions. While lessons were designed to replace some of the tutors of remedial students, the tutors to date have not been laid off but have become managers of the instruction on the microcomputers.

7. Will the computer-based curriculum standardize the rest of the curriculum? In developing the computer-based lessons the general baseline objectives had to be broken down into many more specific and sequenced objectives. Will this become the standard for the day-by-day sequencing of instruction, or will the curriculum specialists and classroom teachers continue to make daily plans for meeting the general objectives?

In addition to greater specificity, there are other differences between computer-based and classroom curricula. There are, for example, discrepancies in terminology for micro and classroom. The format for doing problems is sometimes different for computer and classroom. Which will become the standard? The instructional developers maintain that in the long run teachers will set the standard. However, the expense of modifying instructional programs may prevent this from happening.

8. To what extent is there transfer from working on

microcomputers to classroom work? When students respond to questions presented by the micro, they are given feedback at each step in the computation. When they are in the classroom, there is not this support for each step toward the solution. The student has to know the entire procedure and execute it. Whether micros will help or hinder the development of independence in problem -solving has yet to be explored.

Transfer of the particular computational skills being drilled is also at issue. Generally, the classroom teacher plays an important role in facilitating transfer. Yet, with the teacher often so removed from the microcomputer activity, he/she does not have the information necessary to support such transfer.

9. What are the effects of differential access to micros? In Salerno, micros in elementary and middle schools are limited to students who are below grade level. Clearly, the intent is to provide an additional resource for these students to promote the acquisiton of basic skills. However, this restriction may result in a stigma being associated with using the machine. Moreover, placing micros in a resource center may result in feelings of isolation for some remedial students. Finally, we wonder whether using computers may have relatively low status because it is managed by an aide.

At the high school level, the pattern of access is reversed. The best math students elect to take computer literacy and programming classes. Access to computers in Salerno poses the problem not only of who is left out, but of how those who may use them are permitted to use them. The long-term effects of differential use based on achievement level are not known, but deserve careful research attention.

Update

In the months since our November 1980 visit, the microcomputer program has expanded and some features have changed substantially. Approximately 300 additional TRS-80's (Model III) have been placed in grades 4-6, and almost all of them are located in classrooms. About 70 additional Model III's have been placed in the high schools.

The problem of converting the software for use on the Model III's has been solved through help from the Tandy Corporation, makers of the TRS-80. Now the lessons developed for the Model I will also run on the Model III.

CHAPTER THREE

GRANITE

Introduction

Granite exemplifies a model of innovation in which some district resources and authority are centralized, but in which actual use of microcomputers and decisions about their use are decentralized. The innovation is loosely structured, without explicit policies or curricular goals set by the district. Because the district values diversity, it encourages schools to use microcomputers in ways compatible with their individual philosophies. Granite is unique in that it has a state organization which provides computer services statewide.

Description of Community

Granite is the center of a seven-county metropolitan area in the midwest. The city itself has a population of 370,000 people, while the entire urban area in which it is located totals over 2,000,000. The residents are predominately northern European, with minority populations of native Americans, blacks and Asians. The range of economic groups is represented in the city.

In national polls, the city of Granite is rated highly as a desirable place to live. In the immediate vicinity there are a number of agri-businesses such as grain companies and food processing plants. There are also large insurance firms and technology companies, including major computer companies. The city is near the state capitol and also contains the major state university. Its downtown area is being improved and older segments of the city are undergoing gentrification.

Granite School District

There are 100 schools or programs in the district including 22 secondary schools, 1 middle school and 59 elementary schools, as well as 20 special locations, such as vocational institutes. work-study centers. and special education programs.

The Granite school district is committed to diversity and alternatives. A planning document from the deputy superintendent's office lists these assumptions for planning: maximization of student and parent choice; continuation of elementary and secondary alternatives; centralization of curriculum development with local building responsibility for tailoring curricular expectation to students; and a culturally plural curriculum.

At the elementary level, families are presented with a variety of educational alternatives and are encouraged to choose the program that is most compatible with their child's personality, attitudes and needs. The four available programs are:

> the Contemporary Program, which is organized in traditional grades in a self-contained classroom. The teacher works with children who are learning at many different achievement levels.
>
> the Continuous Progress Program, which is a highly individualized plan. Children grouped into large teams work at their own rate with four or five teachers, specialists, and aides.
>
> the Modified Open Program, in which children are placed in a multi-age team. This team includes teachers, assistants and students who work on basic skills, awareness, involvement and responsibility.
>
> the Fundamentals School Program, in which students are in self-contained classrooms. In this program discipline, a structured curriculum, and parent participation are emphasized.

At the secondary level there are comprehensive senior high schools as well as magnet schools with emphases in particular curricular areas. Vocational education is an important component of the secondary curriculum, as a brochure from the school district describes: "The Secondary Vocational program is a network of occupational courses established throughout the city high schools from which a student can explore occupational skills. Basic vocational courses may be taken in the student's home high school. A student who finds an interest in a basic vocational course may then enroll in specialized Secondary Center courses offered at various high schools and non-high school locations."

The school population is 32 percent minority. Voluntary integration is promoted through innovative programs designed to attract majority and minority students. In line with a 1972 court desegregation order, no school has more than 46 percent minority enrollment.

To serve the needs of non-English speaking immigrants, the district has established Limited English Proficiency programs providing bilingual education and English as a Second Language instruction. Schools specialize in a

particular non-English speaking population, and students are bussed to the appropriate program.

Basic skill achievement, a top priority of the Granite schools, is generally high. Granite students score higher than students nationally on standardized achievement tests in reading, vocabulary and on the verbal and mathematics tests in college admission tests. The district reports basic skill scores annually for every grade in each elementary school.

Per pupil expenditure is approximately $2,300, among the highest in the area. Equipment for instruction is an important budget item, and city businesses provide support for innovative programs in the schools.

The district administration is headed by a Superintendent and a Deputy Superintendent. The Associate Superintendent for Education Services supervises subject area coordinators. Responsibility for instructional computer use is under the mathematics coordinator. His staff includes the district's computer resource person, as well as a mathematics resource person.

Recent Developments Regarding Schools

Recent developments that have influnced the school system include the following:

1. Declining enrollments

From 1968 to 1980, the Granite School District enrollment has dropped from 70,000 to 41,000 pupils. This has resulted in school closings and layoffs of most of the younger staff. As a result, 80 percent of the teachers are at maximum salary levels. The administration reported that some teachers feel a sense of overload, burnout, and stress.

2. Influx of non-English speaking immigrants

For the past year or two, a substantial number of non-English speaking Asian students. many with no previous schooling, have transferred into the Granite schools. The district has reallocated resources to meet their individual needs.

3. Unexpected cut in this year's budget

The state recently decreased Granite's school budget by six million dollars. The system has had to do some painful belt-tightening in response.

4. Development of a centralized computing organization for the state

In 1973, the state legislature mandated access to computer facilities for each district in the state. Four public educational systems (the major state university, the State University System, the Community College System and the State Department of Education and Administration) created the Central Computing Organization. Its primary purpose is to coordinate and provide computer services to students, teachers and educational administrators throughout the state.

Use, Number and Distribution of Microcomputers

There are 80 Apple microcomputers in the Granite school system, 40 are owned by various schools and 40 "loaners," owned by the district. They are distributed throughout the district, with heaviest use at elementary and high schools. At the time of our visit thirteen of the 22 elementary schools, four of eight junior highs and six of the ten high schools had microcomputers.

Schools with microcomputers typically have one or two of them, though the high schools tend to have more. The loaner machines are moved from school to school as requests for them are made. During a given time period, many schools have no micros at all, while others have as many as eight. The district expects to purchase more microcomputers in the near future.

Uses of microcomputers are diverse. They include computer literacy, programming, drill and practice, tutorial, simulation, and games.

Support for Computing

Support for computing comes from both district and state levels. The school district has allocated $150,000 to the instructional computing budget. This budget includes the salaries of the computer resource teacher and her part-time aide. It also pays for the purchase and maintenance of both the microcomputer and the time-share hardware.

The district computer resource person coordinates the purchase of the hardware, distribution of the software and organization of inservice training. She serves as a vital link between the computing organization and the schools in her district. She reports to the district's math supervisor, who has been supportive of instructional computing.

The computer resource teacher spends much of her time on the telephone answering questions from district staff such as, "I've forgotten how you get the machine to do X." She reported that most questions tend to be operational in

nature, but recently some teachers have been asking about available software and the integration of the microcomputer into the curriculum.

There is also support for computing from the Central Computing Organization. Through it, Apple microcomputers can be purchased at a discount. Software is distributed by the organization's staff. The software typically has been developed by teachers, reviewed by other teachers and modified by the organization's staff prior to distribution.

History and Current Organization of Computing in the District

Before Microcomputers

During the mid-60's the Granite School District, and leaders at the nearby university, used time-sharing equipment and produced a mathematics curriculum that integrated the computer with instruction. In the late 60's, after the arrival of the new mathematics coordinator, the district leased time in the evening from a nearby industry. Inservice courses for teachers were begun.

Shortly thereafter, the district first bought time from a computer company, and then from an area educational agency, to provide teachers and students with access to instructional computing. In the early 70's, the Granite School District purchased its own Hewlett-Packard computer, and placed terminals in high schools.

In the mid-70's, the Central Computing Organization made access to instructional computing available throughout the state. Since then the organization has provided the district with instructional and administrative services and data-processing applications. The Granite School District is in one of seven regionally-based service centers located throughout the state. These regions each contain a Management Information Services Division that provides the schools in its region with data processing services.

Granite now has 150 terminals with 32 ports to its own Hewlett-Packard computer, as well as 28 accesses to the Central Computing Organization. The terminals are located in all of the secondary schools and in 3/4 of the elementary schools. Students use the terminals primarily for managed drill and practice in mathematics, for programming, for simulations, and to send electronic mail. The electronic message system is a popular and sometimes abused activity. Teachers use the terminals to maintain records and to generate tests, worksheets and materials.

Introduction of Microcomputers

Teachers and administrators in the Granite School District became interested in the use of microcomputers when the equipment became available on the market. The Central Computing Organization (CCO) was the primary catalyst in Granite's actual decision to purchase microcomputers. The district purchased 40 of the CCO-recommended Apple microcomputers with its own funds. Some schools purchased their own microcomputers from capital outlay funds and grants.

Software acquisition and development. Software acquired and developed by the Central Computing Organization is available free of charge to schools in the Granite School District. It is sent first to the district computer resource person, who sends it to media specialists in each school. Additional software for the Apple microcomputer has been purchased by individual schools out of materials and supplies budgets. Title I money has been used to purchase microcomputers, although there has been some hesitancy from the state on this practice.

Use, values, intent. Though the uses of the microcomputer vary from school to school, they are mainly for supplementary instruction. For teachers, the microcomputer is one additional resource for instruction; a tool to help them do better what they are already doing. Another frequently-mentioned rationale for use is to provide students with an awareness of computers and their applications. Decision-making about type of use is left to individual teachers.

System administrators coordinate computing within the district and support, within budget constraints, the interest that the various schools have. The district computer resource person decides the next location of the district's 40 loaner microcomputers among the many interested schools.

Elementary Level

Features of the Microcomputer Program

Demographics and personnel. We visited six of the 13 elementary schools with microcomputers. These schools represented several different educational options including the contemporary, modified-open and continuous progress programs. They also contained a variety of special programs. All of the schools we visited had significant numbers of minority students. We observed classes and students at all grade levels and in all parts or the city. The majority of elementary students using computers were at the fourth to sixth grade level. Classroom teachers, media specialists and resource teachers supervised microcomputer use.

Training/support. Personnel at the elementary level are trained by the Central Computing Organization, which offers a wide variety of workshops and courses to interested teachers. The district computer resource teacher also offers short courses and workshops and provides day-to-day consultation as needed. Informal inservice takes place when teachers share ideas with each other during preparation periods or after school. Some teachers have taken university programming courses as part of their degree studies.

Equipment. All of the schools visited had one or two computer terminals as well as one or two 32 or 48K Apple II microcomputers with disk drive. Terminals and microcomputers were usually in the same room.

Resource distribution. The Apple microcomputers used in the elementary schools were either purchased by the school or on loan from the district. The district's computer resource teacher allocated microcomputers in response to written requests from teachers. Microcomputers are more prevalant in the upper than in the lower elementary grades. They are located in resource rooms, media centers, and hallways, but rarely in classrooms.

Purpose and relation to curriculum. The purposes for which teachers and media specialists use microcomputers are quite varied. They include programming, supplemental drill, and games.

Because of the diversity of use and relatively small number of machines, it is difficult to specify just how the computer work is related to the curriculum. However, what is striking at the elementary level is that programming has become an accepted part of the curriculum for the upper elementary grades. For the most part, proramming is not taught by classroom teachers. but rather by special teachers.

For example, students identified by teachers as having "high potential" in some area can choose to attend six-week intensive courses. Computer programming is one of the offerings for this high potential group. It is offered in several elementary schools. In the course we observed, children were working independently on the micros or in small groups with the teachers. The students seemed competent and enthusiastic.

In another school, upper elemenary school students who had learned programming the previous year from a high school teacher (the high school teacher and elementary mathematics specialist traded classes for one period a day) are continuing with their programming under the supervision of

the math specialist. In this school, there is also a math enrichment program for students who excel in math. These students play computer games like Herkel and Taxman, and thus learn coordinate graphing and prime factors.

In some schools children are permitted to use microcomputers for games, particularly during elective times. However, the educational value of microcomputer games is a matter of some debate in Granite. While some teachers believe them useful, others do not.

Other than high potential students, two other groups of elementary students use microcomputers in Granite. Learning disabled children are provided opportunities to use the micros, as are a group of non-English speaking Asian students. These students can work with the computer without being self-conscious about their lack of language skills.

Effects and Problems: Administrators

Effects. Several principals supported the use of microcomputers for instruction by allocating funds for hardware or by obtaining grants from local industry to buy hardware. Some principals also created a position for a computer resource person in their school. The principals agreed that the availability of microcomputers helped to attract some students to their schools. Principals are also aware of the administrative uses of micros, and some are already using them for this purpose.

Problems. Even though the Central Organization can provide micros substantially below retail cost, the principals still feel they are too expensive. Using Title I funds is problematic because equipment purchased with these funds must be targeted for Title I students only. Not all principals are enthusiastic about microcomputers. Some report that teachers are not being receptive to the innovation. One principal, for example, reported that teachers are overwhelmed with curricular innovation and are reluctant to learn to use the micro. They ask, "must children have all this multi-modal stimuli to learn? Must we give in to technology?" If principals wish to promote the use of microcomputers. they may need to plan for a mixed reception from teachers.

Looking to the future. Principals would like to increase the number of micros for instruction in their schools in the future. They are also interested in obtaining micros for their own administrative purposes. One, for example, is hoping to obtain an Apple to help him keep track of highly mobile special services students. None of the principals had envisioned a model of how the machines would or could be used in their schools in the future. In

Granite, the microcomputer innovation is very much in its beginnings.

Effects and Problems: Teachers

Effects. There is a growing group of teachers who are interested in learning about computers. Inservice courses are well attended, even on Saturdays. Several teachers have taught themselves to program.

Several teachers' roles were redefined because of their expertise in programming. They have been released from classroom duties to do computer-related work. This involves teaching small groups of students about computer use (including programming) and developing computer courseware. Most of these teachers have switched from mathematics resource positions to computer resource roles, or to teaching high potential students. A few teachers try to get other staff members interested in or informed about the use of computers. Several have written curriculum materials for publishers who want information about computers in their textbooks. Some teachers act as consultants to publishers.

Problems. Most teachers do not have time to take programming courses and thus have insufficient skills to create programs they want. The media specialists, officially assigned to distributing software, feel they do not have time to review software and plan for its effective use in the schools.

Some teachers tend to feel threatened by machines. One teacher reported that others may have fears of being replaced by computers. Some see computers as math machines, to be feared just as math is.

Looking to the future. Teachers hope and anticipate that there will be more micros in their schools in the near future. Because of cost, teachers predicted gradual changes over the next five years. Only one teacher indicated that micros would be in classrooms in the future. The others talked about expansion of current activities by increasing resource room micros and software.

Effects and Problems: Students

Effects. High potential students learn programming. Some of these students become excellent programmers and, ultimatey, analysts. One teacher felt that learning to program helps these bright students become more analytic. Through programming classes, students also learned that there are several ways to solve a given problem. Students themselves felt they were getting better at mathematics and typing.

Some teachers commented that boys seem to work more independently than girls in learning proramming. Boys, one teacher suggested, take the initiative to use computers outside of school. They visit local computer shops and "browse." As a result, they quickly become facile with the machines. One teacher reported that girls seemed uninterested in programming until they were introduced to graphics, which captured their enthusiasm.

Teachers commented on the value of the machines for special students. One emotionally disturbed boy became very motivated through using the microcomputer. He now completes assignments and is eager to learn programming. The new non-English speaking immigrants are starting to feel better about themselves as learners. given their success at the computers. The math drill and practice programs they use are not as language-dependent as traditional school work.

Problems. The main problem we observed was that of access. Often students had to wait their turn to use a micro. Moreover, there may have been greater use by boys than girls of the micros. We observed a total of 23 boys and 14 girls in varied computer locations.

Students also felt they would like to get hard copy as a record of their work. This was possible only with the terminals, since printers were not available for the Apples.

Secondary Level: Junior High Schools

Features of the Microcomputer Program

Demographics and personnel. Microcomputers are used minimally in Granite junior high schools. We visited two of the four junior high schools using microcomputers. Special teachers were in charge of microcomputer use. We observed two general uses: after school informal programs and remediation.

Training/support. Teachers at the junior high school level can attend non-credit district or state mathematics meetings which include computer topics. Other courses for which there is "professional growth credit" are available and provide a salary differential.

Equipment. Both schools visited used Apple II computers.

Resource distribution. Junior high schools acquire microcomputers in the same ways other schools do - through their own funds, special grants, and/or requests for the districts' loaners. Teachers have initiated these acquisitions, with administrators being supportive of the teacher efforts.

Purpose and relation to the curriculum. In the first school we visited, eighth and ninth grade students were learning how to program the computer in an after-school program. The micros were described as the major tool for the club members. Because the teacher was not available to meet with us when we visited the school, we were not able to collect detailed information about the club.

In the second junior high, microcomputers are used for remediation in a Title I reading program, and for remediation and reward in the Title I math program. In the Title I math program two computer terminals are used as well, for math drill and practice. One Apple is placed in a math resource room and students are allowed to use it as a reward for completing other work. The programs, primarily speed drills, are not necessarily related to the mathematics they have been working on. The other Apple is placed in an area adjacent to the library and is used for reading and language remediation. The Title I reading teacher decides which programs should be used. Currently students are using spelling programs. An aide loads the program and supervises the students during their 30 minute time periods.

Effects and Problems: Administrators

Effects. School administrators are supportive of and informed about the uses and potential uses of micros.

Problems. Finding funding for micros is difficult. Lack of funds will restrict their use.

Looking to the future. The one administrator who commented on the future felt that microcomputers, if used properly by teachers, could and should be a serious part of the curriculum. While he thought that every student should have access to micros, he felt that use would continue to be limited because of budgetary restrictions.

Effects and Problems: Students

Effects. A teacher reported that micros are exceptionally effective in maintaining junior high students' attention. A Title I teacher felt that remedial students have a positive attitude about themselves and feel better about coming to the resource room when they can use micros. The interest and envy of other students boosts the morale of those in the Title I program. Because computers were used by high potential students in the elementary schools, students who use them feel a special status.

One principal felt that using micros changes the relationship between students and teachers. He felt the

relationship was more relaxed and that there was more exchange between students and teacher. He noted that, with micros, students help each other learn. He also felt that experience with microcomputers might open up job possibilities for remedial students, many of whom will have difficulty finding jobs.

Problems. When the micros are located in relatively public places they attract an audience. Some remedial students have been teased by on-lookers.

Secondary Level: Senior High Schools

Features of the Microcomputer Program

Demographics and personnel. Six of the ten high schools in the district are currently using microcomputers. Of these we visited four. Each school had both majority and minority students with some of the population bussed in from near-by areas. These senior high schools, like the elementary schools, have program options including open, modified-open, traditional, magnet and regular programs.

In the lower grades media specialists play a key role in monitoring use of the microcomputers. In the high schools, in contrast, the mathematics and business teachers tend to be in charge of the machines. They are also the primary users.

Training/support. High school teachers have the same training opportunities as do other teachers in the district--courses and workshops offered by the Central Computing Organization and by the computer resource person, as well as occasional inservice courses offered in schools.

Equipment. Each high school we visited used Apple II microcomputers. In some cases machines were purchased out of school budgets, and in one case from a state grant. Many of the machines, however, are the districts' loaners.

Resource distribution. In the schools we visited, machines were located and used in a particular department. Use is confined primarily to mathematics and business departments. In one school, however, they are used in the physical education department, and in another the media center houses the micros.

Purpose and relation to the curriculum. The way in which microcomputers are used and their relation to the curriculum varies from school to school. At one high school we observed an unusual program funded by the state. Described as an alternative curriculum for physical education, the program was developed so that students could acquire knowledge and understanding of the rules,

principles and strategies of sports and recreational activities. The software helps students to understand the conceptual aspect of sports, and also evaluates the student's knowledge.

Among the users of this program are students who are physically, mentally and emotionally handicapped. Microcomputers have given them a role in physical education which hitherto had been unavailable. This program is based at a Granite high school, and is being field-tested in four other school districts.

The software for this program was adapted from Central Computing Organization software. The director of this project, who knows how to program, is developing introductory and follow-up "learning packages" to accompany these programs.

This physical education program has also produced interest in other uses of microcomputers. Once this alternative program brought the two Apples into the school, the director gave a workshop on their use to other faculty members. In addition, a small group of mostly male, high achieving mathematics students uses an independent study course as a vehicle for learning programming.

In a second high school, microcomputers are in the media center and the business department labs. The media specialist encourages all staff to use the microcomputers. A band instructor and a home economics teacher used micros in their classes after attending workshops in which the micro was demonstrated and relevant programs were described. Home economics students use the microcomputer to analyze their diets. A programming course was offered as a new elective this year. Surprisingly, there are more girls than boys enrolled in the programming class.

In a third high school, the business and mathematics departments use the microcomputers. The business lab has one Apple, plus terminals and other data processing hardware. The microcomputer is used to teach BASIC programming and some computer literacy. In the mathematics department the computer equipment is used by one teacher and is located in his classroom. He uses available CCO software to teach math. His students learn programming as well. The music teacher in this school has an Apple on loan for use in his classes. Students use drill and practice software to practice music theory skills.

In the fourth high school all of the equipment was located in a computer resource room which was in the mathematics department. The computers are used for elective courses in computer mathematics and computer programming. The chairman, who is writing a workbook on developing algebraic

and geometric concepts through the computer, has begun to use the micro in his introductory algebra course. No other department in this school is using the computer, although the chemistry department has expressed interest in doing so.

Effects and Problems: Administrators

Effects. Administrators support the instructional use of micros, and would also like to use them administratively. One principal was excited about using micros as part of a new secondary center in business management. She felt they may help to attract students to the program. Another principal thought micros would be very effective with students learning English as a second language.

Problems. The cost of micros cannot be covered by the operating budget. Principals are active in trying to obtain outside funding for purchasing the hardware.

Looking to the future. One administrator places neither high priority nor high hopes on increased use of microcomputers in his school. If there is increased interest in computer activities, then existing terminals will be used more. Another principal was excited about the possibility of extensive use of computer managed instruction in the future, while a third hoped to use the Apple for administrative recordkeeping. All administrators were concerned about the financial restrictions on a more serious commitment to microcomputers in the district.

Effects and Problems: Teachers

Effects. Several teachers used micros because they found an available program that was motivating and effective. They seemed interested in exploring the use of the new technology with their students. At one high school, all of the faculty participated in a recent inservice course on micros.

One teacher said he needs to learn how to work with groups, since students work in small groups with the micro. They do not work in groups in other activities in his classroom.

With declining enrollments, teaching jobs are decreasing. Some teachers view the micro as a tool to help them learn programming skills which can lead to jobs in business or industry. Others find their computer expertise helps them to keep the positions they have. One business teacher we interviewed had kept her job because she was the only one who could offer the computer-related courses.

Problems. Teachers predicted that the growth of microcomputers would be hampered by lack of funds. One media specialist noted that she was permitted to use her

equipment budget to buy micros. Purchasing only one, however, would take the entire year's budget.

At the present time, computers are identified with the math department. Teachers questioned how to encourage their use across several curricular areas. Teachers hoped that better and more varied software would make the computer a more versatile educational tool.

A principal felt that teacher organizations are wary of computer use because of job security. His impression was that teachers feel threatened by their lack of knowledge about microcomputers but do not openly discuss these feelings.

Looking to the future. Teachers varied in their hopes and expectations about the future. Some wanted one or more microcomputers per classroom, in addition to teachers who are sufficiently trained in programming to create their own software. Some looked forward to more extensive software in their area--music history, consumer economics--to make possible increased use of micros. Others said they would prefer more time-shared terminals to more microcomputers, because of the availability of business languages and hard copy. In general, most teachers envisioned a future not dramatically different from the present.

Effects and Problems: Students

Effects. Some teachers commented that programming taught students logical thinking skills or some systematic problem-solving skills. Students we talked with felt that they had learned to be logical and analytic while programming. They felt they could use this skill in doing math proofs, but not in their daily lives. One student who used the computer to solve calculus problems felt micros encouraged him to be more experimental, to try a variety of approaches to solving a problem.

Several advanced students felt micros were more appropriate than terminals for beginning programming classes because they were easy to use and didn't break down as frequently as terminals. However, they felt that advanced students needed terminals in order to have access to a variety of programming languages.

In the social realm, one teacher proposed that students may develop skills of collaboration, since they work in groups on the microcomputer.

The special microcomputer program in physical education has had an important impact on physically handicapped adolescents. A teacher cited an extreme case of a fifteen year old, profoundly handicapped boy who could never

participate in physical activities. Through the microcomputer-based instruction, he learned statistical analysis and applied it to the records of his active peers. As team statistician he gained a valued status among his peers.

Problems. The use of microcomputers by interested students, especially those who want to program, is hindered by the shortage of teachers with expertise. This problem will increase as more students learn programming in the lower grades. Some will be very proficient by the time they enter high school.

At the high school level, programming classes in the mathematics departments and data processing classes in the business departments had a majority of males (except for one school where there was a tradition of having majority of females in advanced mathematics courses). In classrooms and centers where we observed, there was a total of 88 boys and 25 girls. In addition, only boys are avid users, spending time during study halls and after school. When asked why girls aren't so active, one boy suggested that "the boys don't give them a chance."

District Level

Effects and Problems: District Administrators

Effects. The district administrators we spoke with were supportive of microcomputers in their district, and assumed that the use of technology in Granite would increase. The commitment to microcomputers has affected the key administrators in that they have all begun to anticipate long-range planning for computers. Such planning is challenging in the context of a school system which values pluralism. The Board of Education is creating a five-year plan for the district, which includes a plan for technology.

Problems. The associate superintendent most directly connected with the microcomputer implementation has many questions about the microcomputers and their status in the school system. Is the micro instructional or supplementary? How can it fit in with a school system deeply committed to a developmental approach? She is very concerned that the district not make purchases which it will later regret. Some past equipment purchases were later acknowledged to have been mistakes.

This administrator finds the micros hard to peg. Are they like what came before, or are they different? Are they potentially an important part of the school system? She thinks probably so, but that a great deal depends on what is developed in the commercial marketplace.

She sees some problems with the current use of microcomputers in Granite. Some schools take the initiative to get micros, while others don't. There is equal access, but not equal use. There are sex differences in who uses the machines, despite awareness of this as a problem. Yet, she indicated that any unused funds in her budget this year would pay for additional Apples because people want them and the district is already heavily invested in them.

Administrators less directly connected with the microcomputers see financial problems as being the main obstacle to expanded use. One talked about the possibility of obtaining some support from local computer corporations. In a system where funds and enrollments are declining, it's not clear how the technology will be paid for.

Looking to the future. Administrators see technology as potentially changing education at its core. They spoke about the possibility that a great deal of instruction would be delivered directly at home through technology, and that the concept of the school would change. Schools, they thought, would be places where students convene with facilitators. Schools would provide the social aspect of education, while homes would focus on what is usually thought of as learning. In such a world, the role of teachers would change dramatically. They would, it was proposed, become the creators of interactive materials.

In no sense was this view of the future being planned for by Granite administrators. Rather, it was something which they expected to happen eventually, as an outgrowth of the technology itself.

Issues from Granite

There are a number of issues which are raised by the Granite implementation. Because there are so few microcomputers in Granite relative to the number of students, however, it is difficult to know whether the issues which are salient now will continue to be so when resources are more plentiful.

1. Who has access to microcomputers in Granite? District loaner machines, in principle available to all schools, go to those schools which have a teacher, media specialist or principal who takes the initiative to request machines. Therefore, some schools have micros and others do not. A student's access to microcomputers depends, in part, on the school she attends.

There is, in addition, unequal access based on achievement level. High potential students are among those who use the micros most at the elementary level, while in the junior high schools learning disabled students are permitted special access. In high school, use is primarily for students who take business math, data processing and computer math courses. Particularly at the high school level, but possibly also before that, girls use computers much less than boys. In Granite, it would appear that average students and girls are using computers less than other students.

2. How can teachers and media specialists be adequately prepared for using microcomputers? Even with access to teacher training and to catalogs describing available software, teachers and media specialists report that they need to become better informed about how to use computers. The teachers making the most extensive use of microcomputers invested significant amounts of time, and in some cases money, to develop their skills. Many had taken courses at a university or had attended government-sponsored summer institutes. In Granite, teachers do not have much expertise to call on from within the school. Computer resource personnel are often busy and far away. How teachers can get sufficient help, time and training to use a microcomputer is a difficult issue.

3. Will the location of microcomputers in media centers define their role as supplemental? Particularly at the elementary level, resource teachers are the major distributors and users of machines. This is in line with CCO recommendations. It is possible, however, that the relatively low use of machines by classroom teachers is a result of this plan for distribution and use. It is also possible that such a plan perpetuates the notion that microcomputers are just like any other audio-visual materials, to be used infrequently and as a supplement to

classroom curriculum. There are those in the district who want to foster increased teacher involvement and integration of the computer with the classroom curriculum. Such goals may be difficult to achieve with this model of distribution and use.

4. What effect does the district loaner program have on the purchase of microcomputers by schools? The district initiated the loaner policy in order to interest schools in using, and ultimately purchasing, microcomputers for themselves. While no systematic study has been done, we were told by personnel in several schools that they had purchased one microcomputer after having experience with the loaner machines. Thus, the availability of the loaners may have spurred purchases which would not have otherwise been made. On the other hand, it is possible that the availability of loaners has permitted some schools to rely less on their own resources and more on those of the district. This model of stimulating an innovation is an interesting one to investigate.

5. How can the school system respond to the increasing levels of student expertise? Students, particularly at the high school level, are faced with teachers who know considerably less than they do about computers. In some cases students and teachers can learn together, but in others teachers are simply not knowledgeable enough to meet students' needs. The system, unable to hire experienced programming teachers in an era of cutbacks, can meet these demands only with further teacher training. Since such opportunities are voluntary, it is not clear how long it will take before there is sufficient teacher expertise. What is clear, however, is that students will learn to program earlier and earlier in the system, thus increasing the demand for better trained teachers.

Update

Since our December, 1980, visit to Granite there have been new developments in the microcomputer implementation. Sixty-six Apple systems have been purchased by schools with matching grants from the district's budget. A five-year implementation plan has been designed. A series of free courses for school personnel has been set up, and will begin in the fall of 1981. Administrative uses of microcomputers by school administrators are increasing rapidly.

GRANITE SUBURBS

Introduction

As part of our visit to Granite we visited three suburbs which were using microcomputers in schools-Lynville, Harrison and Forest Hills. Since Granite and its suburbs could use the services of the state-wide Central Computing Organization, we wondered if the sites would be replications of a single model of computer use. We found that each suburb had developed its own approach, typically under the leadership of one person who was particularly enthusiastic and skilled in instructional applications of computer technology. One feature shared by two of the sites and in line with the policy recommended by the Central Computing Organization was the placement of the micros in media centers. Micros were used by teachers as supplements to instruction - either the teacher borrowed a micro for a relatively short period of time, or students were sent to the media center to work on a particular program.

There were unique features at each site, as well as some common problems and issues. Our experience in the suburbs suggests that the individuals and the community are powerful forces in shaping the implementation of microcomputers.

Lynville Public Schools

The Lynville Public School District is a suburban school system adjacent to the Granite School District. Lynville is essentially a middle and upper middle class community of 80,000 with a total of 21 schools. The community includes professional, technical, and blue collar workers. and retirees.

As with many surrounding school districts, the student population has decreased dramatically. Lynville's current enrollment is around 15,000 students, down from the 25,000 it served 10 years ago. In fact, one of the large computer companies in the community just purchased one of the closed elementary schools and is remodeling it for corporate offices.

The district currently has 50 Apple microcomputers, all of which are used for instructional purposes. Each of the 21 schools in the district has at least one microcomputer. Students' computer activities include drill and practice, problem solving and simulations in many subject areas. Computer science concepts, such as awareness and training in the application of computers, are included in the elementary through senior high programs.

History and Current Organization of Computing in the District

Lynville initiated its instructional computer service in 1967 by central purchase of time share terminals for each secondary school. These terminals, supported by local business equipment and staff, were placed in the mathematics departments. After inservice training, teachers were assigned as terminal supervisors. Some of them still retain that responsibility. The district's director of computer services has handled the allocation of time and distribution of programs to each school. In the early 70's, more computer terminals were purchased with Title III money. The machines were set up to travel to all of the schools. At the same time, the state began to subsidize the communication costs of instructional computing, making the phone lines essentially free. This spurred terminal purchases by senior high schools and some elementary schools with their own funds. Lynville was one of the first members of a regional computing consortium made up of nearby suburban communities.

In 1978, after the CCO made discounted Apples available, the schools in the district purchased 15 Apple II microcomputers out of their own budgets. In 1979, 15 more microcomputers were purchased by the district for distribution to schools through the Instructional Media Centers. Several microcomputers are loaned at one time to a school, so that there can be significant access and use.

In the past 2 1/2 years, PTA and school budgets have helped increase the total number of microcomputers to 50.

Elementary Level

We visited two elementary schools, one junior high school and one senior high school. At the first elementary school, the one Apple microcomputer and the one time-sharing terminal were kept in a small room in the media center. The microcomputer had been purchased with capital outlay funds, while some commercial software was purchased with Title IV-B funds.

The resource center director organized and supervised the use of the machines. She emphasized that microcomputer activities were supplemental to the elementary program, primarily in mathematics and reading. The programs she used on the microcomputer were single concept; in reading the emphasis was on spelling words and phonetic skills. She did not think that the computer programs would ever become a "basal series" for teachers at that school.

The resource center director has set up computer use classes for all students at the school. The kindergarten, first and second graders have programs loaded for them and they work on initial number and letter concepts. The third and fourth graders learn how to log in and log out of the time share system. Fifth and sixth graders learn how to operate the microcomputer and then do some beginning and intermediate programming.

Students come in for computer math every day. Though both the boys and girls are interested in working with the computers, boys tend to stay after school and use them more often. The resource center director thought that the interest of high ability students came from the challenge of working with the machine. She proposed that the low ability students love working with the computer because they experience success and because it differs from typical school activities.

The resource center director has conducted inservice programs with the staff so they know what types of programs are available. She plans to acquire some management programs and thinks the teachers will like them, though some teachers have a fear about being replaced by the computer. She would like to see a microcomputer in every classroom for supplemental work. She believes there are too many problems working with time-share systems.

At the other elementary school, two Apple microcomputers and three time-sharing terminals are in the resource center. One of the microcomputers is open to the special education students to work on phonics, spelling, and

mathematics. There is an aide who assists the children using the micro. She is paid partly with special education funds. The heaviest users are the sixth graders who use an individualized mathematics program for an average of one full day per week. Computer use is one of many laboratory activities that students may pursue in a rotating fashion. About one day a week is set aside for instructional computing or computer literacy. Computer literacy activities occur at the end of fifth grade or beginning of sixth grade.

The resource center director thought that both high and low achievers found the microcomputer equally motivating, except when the task was too easy or too hard. She felt that the drill and practice programs have a very positive carry-over: students work at home so they can do better on the computer the next time. The end result is that they do do better. The time-consuming logging- in process is a disadvantage to using the terminals. Students go to the Apple if they don't have much time. If they want a copy of the results, they go to the teletype terminals. Consequently, some of next year's funds (Title IV-B) will go towards purchase of a printer for the Apple.

Secondary Level

The junior high school we visited had 1250 students, with two of its own Apples and six Apples on loan from the district's pool. There were seven in a mathematics classroom and one in the media center. The use and maintenance of the machines is coordinated by the media center teacher. When the school has the extra machines, the seven Apples are rotated around the mathematics classes, for three days at a time.

In one eighth grade class, students were in their second of the three-day literacy unit that is part of their mathematics class. One half of the class was doing worksheets, "playing computer" by trying to debug programs given to them, while the other half of the class was working with the computers, usually two or three to a machine. The software was furnished by the Central Computing Organization. The teacher and all of the students seemed interested in working with the computer. Three fathers had come in as guest speakers to the class during this computer literacy unit. One was a senior analyst, one was a program director and the third a computer designer, all for large computer companies in the area.

The 10 mathematics teachers were given four or five inservice sessions after school, though several of them didn't attend. Those who did, however, are very excited about the use of microcomputers. They feel that it meets the needs of those students who can program, and that there

are some who could also use it for drill and practice, though this use was slow to catch on.

Teachers thought that the higher achievers want to program more and the low achievers want to play the computer games. With the high achievers, we did not observe any differences between boys' and girls' interest in computing. Among the low achievers, very few girls were interested.

There is parental pressure for students to use the computer. In fact, one father who worked for a large computer company had a computer terminal at home and wanted the passwords of the school's time sharing computers so that the boy could work at home. Because the student did not want to work on drill and practice at home, he stopped using the school's programs.

Teachers felt that in the future, if there were sufficient funds, they would want to buy more Apple equipment and to hire a programmer to write software for them.

At the high school, the biggest user of the microcomputer and time-sharing equipment was the science department. A course called Computer Technology includes programming, computer literacy components, and paper and pencil activities. In four sections of the computer technology class, each with 24 students, there were three girls per section.

The physics, economics, chemistry and biology teachers have used the computers with teacher-created software as well as software from the Central Computing Organization. The person who had developed the computer program at the high school had just taken a position in industry. Other members of the science department were working on new activities. Teachers felt that, as more Apples were purchased, the impact could grow. Adequate teaching with microcomputers requires more machines than are now available.

Issues and Problems from Lynville

1. What should be the funding priorities for the district? The computer coordinators (math or science chairman in the high schools and media specialists in the elementary and junior high schools) want to spend computer money on support staff and the development of an overall program for the district. School principals, however, want to spend the money on hardware.

2. How should computers be used? There is no unified approach to computers in the district. In the absence of clear plans or policies, decisions about future programs or spending are difficult to make.

3. How can local software be shared and quality software be found? There is an interest in sharing non-copyrighted microcomputer software from Lynville's schools with other school districts. There is not, however, an organized procedure for such interchange. With such a procedure, teachers might be able to find instructional programs which are more complex and challenging than what they now have.

4. How can staff be found and/or trained to meet the programming needs of students? A district goal is that the students who need knowledge in computer science should be provided opportunities to obtain it. There is not now adequate staff to meet these needs.

Harrison Public Schools

Harrison is a middle to upper middle class suburban community with a population of 41,000 and a total of 16 schools. The population is primarily white. There is a small, low income population qualifying for Title I services. Parents have high expectations for their children's school achievement and actively participate through parent teacher organizations and as classroom volunteers in shaping the curriculum to emphasize academic achievement.

Microcomputers are used instructionally in all schools in the district. Their use is diverse, and grows out of the interests and initiative of individuals in each school. The use of microcomputers is administered by the Evaluation Center of the school district and has evolved from its work with a computer-based instructional management system.

History and Current Organization of Computing in the District

Beginning in 1970, the instructional management system ran on a mainframe batch process basis. The computer was available through a regional computing consortium, and data were processed at night. The district developed materials to disseminate information about the system and to train others in its use. While there were many expressions of interest, most potential adoptors found that the system, designed for use on large computers, was too expensive to be feasible. In 1978, in response to the cost limitation, a programmer was hired to adapt the system for use on microcomputers. By the summer of 1979, a program that could provide profiles of achievement was available for a 48K Apple. This version has been disseminated to over 75 school districts.

In 1978, there were two other developments that shaped the use of microcomputers in the district. Harrison purchased one Radio Shack Level II microcomputer and placed it in schools on a short-term, experimental basis. Administrators and teachers were to learn about potential instructional uses of microcomputers. In addition, a task force, comprised of teachers, media specialists, curriculum specialists, and parents, was formed to develop district guidelines for the role of technology in the school.

The task force decided that it was too early to specify a role for microcomputers. The potential of the equipment was great, but knowledge of how to capitalize on that potential was small. The task force recommended the purchase of more microcomputers, without a particular plan for their use. The task force evaluated the Radio Shack computer, as well as the PET, TRS-80 and Apple, and recommended the purchase of Apples in the future.

That summer, sixteen Apples were purchased with district funds. There was one for each school building, along with five additional Apples that could be borrowed from the district office for special purposes. In the 1979-1980 academic year, a new staff member was hired by the Evaluation Office to visit schools and conduct inservice training on instructional uses of microcomputers. In addition, the responsibilities of the programmer hired to adapt the instructional management system were expanded. Half of his time was spent developing instructional software and supervising high school students doing advanced programming. These students helped to create instructional programs for teachers at all grade levels.

The district now has two goals for microcomputer use. First, that every elementary school student spend some time with the microcomputer and, second, that all teachers are minimally competent in the use of the micro.

In each elementary school, the media specialist coordinates access to and use of microcomputers as well as inservice for teachers. She/he is responsible for being familiar with available software and for informing teachers of programs that they may find useful. Often the micros are kept in the media center, and students are sent out of the classroom to work with the equipment. In some schools, one or more additional micros are available to be moved into classrooms in response to the requests of teachers. "Computer Moms," parent volunteers who help children learn to use the computer, are available in some schools to assist the media specialist or classroom teacher.

Elementary Level

The researchers visited two elementary schools. At one of the elementary schools, a new Apple, bought with PTO funds, was placed in classrooms as teachers requested it. It was also used with learning disabled students for two hours a day. Two other Apples, purchased with building funds, were kept in a small room off of the media center. Teachers signed up for 1/2 hour blocks of time for their students.

During the site visit, four fourth grade students had been sent to work with the machines for the entire 1/2 hour. The children worked in pairs, and were to complete at least one math program and a "Hangman" spelling program which had in it words from the spelling curriculum. After finishing the assigned lessons, they could select any other program. These students chose simulation programs, such as "The Oregon Trail," and they collaborated on decision-making during the simulation.

For most of the period, these students were not directly

supervised by the media specialist. They knew what they were supposed to do with the machine, knew how to select programs, and worked eagerly for the entire period. There were occasional misunderstandings about how a program worked, but the students seemed challenged to figure out the rules. The students reported that they liked working with the computer and said they had learned mathematics and spelling through using it. They also said they couldn't learn art or science through the microcomputer, because the computer couldn't provide the hands-on demonstrations that are important in those subjects.

The media specialist had been trained to use micros through inservice courses from a regional computing consortium and also through college courses which she had taken voluntarily during the summer. The district implementation specialist conducted inservice training for all teachers in this school last year. The media specialist hopes that the implementation specialist will spend time in classrooms this year, working directly with teachers and students. District administrators had planned to purchase more hardware for this year because hardware requests have exceeded their supply. A media specialist indicated that the group responsible for school implementation persuaded the administrators to use a large part of the money for softwa. . Neither teachers nor media specialists have time to write their own programs.

Some parents in the Parent Teacher Organization (PTO) have opposed the use of microcomputers in schools because they believe the machines are used chiefly for games. Such use, they feel, detracts from academic achievement. The media specialist agrees that some concern is legitimate, because there is a lack of high quality software. Last year she borrowed seven micros and brought them to a PTO meeting. Children demonstrated how they were used in school, and parents in general were favorably impressed. This year the PTO is sharing the cost of a microcomputer with the school.

The media specialist's goal for the micro program is to have all students familiar with the microcomputer. Last year she arranged for all students in grades four through six to have some time with the machines, and this year all students in kindergarten through third grade will work with them.

The media specialist has noticed that working with the computer has promoted social and academic development for some students. Some shy children became exceptionally competent with the computer and began helping others. Girls avoided using the computer at first, but are now enthusiastic users. In general, all students, even kindergarten children, enjoy the microcomputer. She feels that the teachers now need opportunities to become

comfortable with the equipment so they will use it in their classrooms. She notes that while money is often available to start new programs, funds are lacking to develop and refine them or to provide supervision for program implementation.

At the second elementary school, we met with a sixth grade teacher who had developed a program to teach proofreading skills. She described the microcomputer as a motivating medium. The idea for a program in language arts was sparked when a student commented that it was so much fun to work with the computer, she'd even do a lesson about language if it were on the machine. As part of an inservice course, the teacher wrote her proofreading program.

The teacher assigns several students to work together on a program. Part of her inservice training focussed on using cooperative grouping for working with the Apples. She has found that students at all ability levels are enthusiastic about working with the computer and that the more able students helped the others.

When we visited, one micro was being used in the special education program. It was in a soundproof room, where students used it individually for drill and practice. One other micro was in the library, where individual children were sent to work with the machine.

Secondary Level

At the secondary level, we visited one junior high school. The microcomputers are in a small room at the back of a combination gymnasium/auditorium/cafeteria. Three Apples and several terminals are packed into the room. The equipment is used in three different ways: students come to the room to play games and to work on their own programs; special education students work on drill and practice programs; and there is a minicourse in programming for ninth grade students. A former math teacher gives the course and supervises the room. He said that some students have become very experienced programmers through a summer gifted and talented program. With access to the equipment they can maintain and expand their skills. The teacher has not had any training in programming, so some of the students are considerably more advanced than he is. This does not present problems for him.

Students who come in during a choice period tend to be low achievers. The teacher feels that working with computers may be one of the few ways in which these children experience success. He reported that special education faculty have been impressed because some children who have difficulty completing any work in class will concentrate

intently for 40 minutes when working with the computer.

There tend to be more boys than girls in programming classes. Few girls come in to play games. This teacher feels the games are more oriented to interests of boys. The teacher finds that when he teaches programming his classes are much more individualized. He must ask each student why a particular procedure is being used, rather than expect everyone to use the same procedure. He wants to encourage the more expert students to help the others. The experts typically do things for other students rather than help them to solve their own problems.

He feel that in the future micros will be more involved in daily classroom instruction. But the paucity of software for various curriculum areas will limit their use.

Issues and Problems from Harrison

1. Should instructional and management uses of computers be administered by the same office? This issue is presently being explored within the school district. The Evaluation Office has not been involved in developing curricular materials, except for writing a computer literacy curriculum and for programming courseware that teachers have requested. The Evaluation Office has assumed these responsibilities because personnel with the technical, programming expertise were employed there. However, the Evaluation Office's hiring of a computer resource teacher was controversial. Some people felt it would be more appropriate for such a person to be hired by the Curriculum Division.

2. How can appropriate software be identified or developed? Already media specialists in Harrison have made software a priority over hardware for budget allocations. No one in the system has the explicit responsibility of recommending software purchases. Harrison is part of a regional computing consortium, which serves as a source of software. But there is no mechanism for familiarizing teachers with the range of options that are available. Teachers and parents want software that relates to the curriculum.

3. How can personnel be trained to direct the implementation of instructional computing at the elementary school level? In Harrison, the media specialists are charged with promoting the use of micros. However, they do not have enough time in load to become familiar with the hardware, to keep informed of software developments, or to evaluate software packages. They do not have the time or the skills for authoring programs that may be of interest to teachers. Individual teachers can be trained in programming, but programming may be an inefficient use of

their time. The district tries to provide for teachers' needs by using a professional programmer supported by skilled high school student programmers. At present they write programs for the high school where the need is greatest.

Because of declining enrollments and school closings, Harrison cannot hire new staff to work with computers. Present staff must be trained for this new function. The plan is to train individuals in each building so that in two years the district-level position for implementation can be discontinued. However, it's not clear that the faculty will develop sufficient expertise without released time for extensive training.

Forest Hills Public Schools

The Forest Hills Area Schools, an independent school district adjacent to Granite is made up of several middle and upper middle income suburban communities. The 20,000 students being served is a decrease from 28,000 six years ago.

Our visit to Forest Hills focussed on a special project which has been the impetus for microcomputers in the district. A three-year "microcomputers in education" development project funded by Title IV-C has brought microcomputers to Forest Hills. Its main focus is to develop and test in classrooms a series of microcomputer programs for the elementary school curriculum. Teacher training is also part of the project. Project personnel have chosen to deviate from the state's "recommended" Apple hardware and purchase Commodore Pets. In addition, they are developing the software and training the staff of 15 public and three non-public schools on their own. The director of the project is also the district's math-science coordinator. His work for the past 15 years has been in instructional computing. The district now owns 80 Pets, and the PTA is interested in buying six more soon. A portion of the Title IV-C budget was used to help purchase this equipment. PTA and school funds also contributed to the equipment purchase.

Before the microcomputer project began the district had been using time-share terminals, accessing the Central Computing Organization. There are now six terminals in the district, a decrease from twelve a few years ago. These are used primarily for guidance and career instruction in the secondary schools.

Microcomputer Project

The project is now in its second year. The first year was spent developing and testing the computer programs. Software has been written for the Pets at the elementary level in the areas of mathematics, science, language arts, reading, career education, spelling, and special education. These programs are designed to make the computer into an instructional device to be used in the classroom by the teacher.

Ideas for programs generally originate with classroom teachers. There are many avenues by which teachers get requests into the project staff: through inservice workshops, staff meetings, and through a building representative for the project. The programs are developed by project staff, then tested by teachers in a minimum of three of the 18 schools. Revision occurs, along with documentation, before the tapes are placed in the schools

for teacher use.

The Forest Hills project also helped provide inservice training for the staff. Each elementary staff person at the 18 schools received two half-hour sessions on the project. Then one "key teacher" from each school participated in two half-day workshops. It is these key teachers who test the software. Later that year, about 100 staff people received a 16-hour inservice class related to the computer. Half of the time was devoted to programming in BASIC, the rest to operation of the specific machine. Project staff report that the teachers who took this course are those who feel most at ease with the computer in their classrooms.

The project is based on the assumption that the computer can support and supplement instruction at all grade levels and in any subject area. Programs are usually drill and practice, simulations, or tutorials. Of the computer programs developed, 25 are for mathematics, 16 for reading and language arts, 9 for spelling, 7 for social studies, and 6 for special education.

Microcomputers are in all of the elementary schools. School media specialists are responsible for keeping track of the hardware and software, for housing it, and for rotating the machines to classrooms. Consistent with the goals of the project, almost all machines are used in classrooms.

We visited one of the participating elementary schools, observed the project's software in use, and interviewed students and faculty. One first grader who was practicing addition problems on the computer and who had used the machine last year in kindergarten, remarked that he liked working with the computer because "It didn't give grades" and because "I have to get my brain into it."

The principal of the building who classified himself as an "old-timer," as one who has seen all the innovations, remarked that the computer really was in a different category than the others. He felt it would be more of an aide to teaching than were earlier innovations.

One teacher remarked that the computer complemented the rest of the classroom activities. She told of a mother who commented about the changes in her child's attitude since working with the computer. The child had said, "when I can't do 3+8, it gives me a chance to try and try again. It makes me do it over and over again and I don't get mad."

Another elementary teacher told of seeing her students use a computer for the first time. She watched their excitement and decided she should have computers available more often, despite her own lack of knowledge. She decided

she could grow a bit herself and learn with her students. Now she and her students are evaluating the couseware together.

The general consensus of teachers in this elementary school was that the computer would become an integral part of their teaching very soon. They are pleased at this prospect.

The project staff, working together on a demanding schedule, has become a close-knit group. The project staff is competent, as well as committed. The courseware they are developing is already gaining an excellent reputation around the country. As planned, an evaluation of the effectiveness of this project will be conducted within the granting period. This evaluation could prove helpful to others as they decide to use microcomputers in the classrooms.

Teachers in Forest Hills did not complain about poor quality software. They themselves had provided the ideas for software. They generally asked for software which matched part of their curriculum. They were happy with what they had, although they wanted more of it sooner. They were, however, willing to be patient and wait for software which met district standards.

Teachers seem to feel comfortable with the computer and in control of its use. The "key teacher" concept has worked to provide help within buildings. The computer is clearly understood to be supplementing the ongoing curriculum and providing the means for computer awareness.

The only problem that anyone spoke of was the need for more equipment. Teachers seem to agree that the place for the equipment is in the classroom. That commitment reflects a real involvement among the teachers. It also produces a demand for more machines.

CHAPTER FOUR

GREENVIEW

Introduction

Greenview is a model of an innovation in which most authority and initiative have been at the grass roots level, with central administrators providing support and encouragement. Early decisions about use have been decentralized. Comprehensive policies and plans for microcomputers are just beginning to be formulated. Greenview is unique in the emergence of a new role, the teacher buff.

Description or Community

Greenview is a suburban community in the northeast about 15 miles from a large city. Its population of approximately 25,000 residents consists largely of upper middle class business and professional persons who work outside of Greenview. There are no major industries in Greenview itself. The population is highly educated, and almost 80% of the graduates or Greenview High School attend college. The primarily black minority population is small, comprising less that 5% of the population

Residents are proud or Greenview's schools and say that the school system's excellent reputation has attracted new families to the community. Students in Greenview score above national norms on standardized tests. In general, the school system is eager to keep abreast or educational innovations, and to maintain its emphasis on preparing students for college and for professional and business careers.

Greenview School District

The Greenview school system serves approximately 5,500 students and consists of seven elementary schools, two junior high schools and one senior high school. Its central administrative staff are a superintendent and two assistant superintendents, one for elementary and one for secondary education. School principals report to the assistant superintendents, as do curricular coordinators. The latter include coordinators for mathematics, art, music, physical education and computing education.

The community monitors the activities of its schools through the Board of Education, and through Home and School Associations which play an active role in each school. The teachers have a professonal organization, Greenview Education Organization, which negotiates contracts for them.

The Greenview school system receives 90% of its financial support from local monies. In the past, the community has been wary of government funding because of its potential impact on local autonomy. Current budgetary pressures, however, have resulted in increased efforts to seek outside funds.

Recent Developments Regarding Schools

1. Budgetary Concerns

School districts across the state have been subject to state-imposed limits on education budget increments. This is an attempt to provide cross-state equity in expenditures. Current growth limits for Greenview are 7 1/2 percent. In addition, school enrollments have declined by a total of 1,000 students (or 15 percent) over the last 10 years. Therefore, there have been reductions in staff and limits on new hiring. The teacher population is relatively old, and relatively well paid. A new contract is under negotiation. These facts, along with a recent local tax increase which was strongly opposed, make for widespread concern about budgetary issues. They could affect additional monetary commitments to computing in the district.

2. Gifted and Talented Lobby

An active group or parents is concerned that the schools more adequately serve the needs of gifted and talented students. These parents want more electives for gifted children. Some see the computer as a source of more advanced curriculum. Others view gifted and talented programs and computing as being in competition for funds.

3. Teacher Accountability

Teachers, according to state mandate, must put in writing their professional improvement objectives for the year. These form the basis for an evaluation at the end of the year.

4. Dissatisfaction with Inservice Courses

There has been some dissatisfaction at the district level with inservice courses for teachers. Some courses are seen as not contributing sufficiently to professional growth. Courses in microcomputers are viewed as desirable, because they are substantive and serious.

5. Movement Towards Centralization

There are plans to make the school system more centralized with respect to issues of curriculum, accountability and

evaluation. A detailed set of objectives is being developed for each curricular area with criterion referenced tests keyed to these objectives. The district owns a computer which it uses for administrative purposes. Consultants are now devising a system to store and analyze profiles of student performance on criterion referenced tests over their years in the system.

Use, Number and Distribution of Microcomputers

There are 38 microcomputers - 35 Commodore Pets and three Apple II's - in the district, used primarily in the seven elementary schools and two junior high schools. Twenty-three Pets are distributed among the elementary schools. Three Apples and five Pets are in the junior high schools. Three Pets are in the high school, and four Pets are available on loan. The microcomputers are used for a variety of purposes, including the remediation and reinforcement of basic skills, computer literacy, and programming.

There are, in addition, time-share terminals at the secondary level. The senior high school has a PDP-11 minicomputer with 14 terminals. The junior high schools have eight terminals.

Support for Computing

Financial support and resources for computing in Greenview come almost exclusively from within the district. First, there is an appointed coordinator for computing education who has played a major role in initiating and expanding computing in the district. In the past she has managed the instructional computing budget. She continues to make recommendations for purchases. As a member of the high school faculty, she teaches programming, manages the computer center and supervises the computer clubs. Two members of the junior high schools' math departments act in a supplementary coordinating role. They have in-load time each day to coordinate computer-related work in their respective schools.

Second, the district provides inservice training. District courses in microcomputers are offered frequently, staffed by local teachers. In the summer of 1980, teachers from many of the elementary schools took a 15-hour programming course sponsored by the district. These people now are assuming leadership roles in their schools. In addition the district makes a contribution towards tuition for teachers who take computer-related courses in nearby training institutions. Several teachers have taken credit courses in microcomputer applications in education.

Third, there is a line item in the district budget for

computer instruction. There was a large expenditure from this fund to upgrade the PDP-11. This money was also used to purchase the first group of microcomputers in the system. This financial support is concrete evidence of both the administration's and the community's commitment to a microcomputer program. It is part of a larger commitment to prepare children for a world in which microcomputers will be commonplace.

History and Current Organization of Computing in the District

Before Microcomputers

Early in the 1960's, on the recommendation of an evaluation team, an assistant principal for curriculum was appointed to the high school. Looking for ways to improve and modernize curriculum, he became enthusiastic about the educational potential of computers. With a teacher from the math department, now the coordinator of computer instruction, he proposed a computer education program to the Board of Education.

At first Greenview used a time-sharing system with another community. The math teacher was given summer training in programming. In 1968 the Board purchased an IBM 1130 computer for administrative and instructional purposes.

It became apparent that dual use for both administration and instruction was difficult to manage. Therefore, in 1974 the Board purchased a PDP-11 minicomputer for instructional use only. Terminals were installed in both secondary and elementary schools. The terminals were used primarily in the junior and senior high schools, where they were placed in separate computer resource centers. In the elementary schools, the terminals were used very little.

In 1979 the district invested heavily in upgrading the PDP-11 because of increased use in the high school. Without the upgrading, it was argued, junior high school terminals would have to be reallocated to the senior high school. The minicomputer has been used to teach programming, for skills remediation, in business math, and for some simulations in economics, history and psychology.

Introduction of Microcomputers

In 1978 the computer coordinator purchased a Pet computer for the high school resource room. In the spring of 1979, six more Pets were ordered. That summer there was a project to develop software. Four elementary teachers specified software they would like for their classrooms and high school programmers created software in collaboration with these teachers.

In the fall of 1979, each elementary school was given one microcomputer and a users' inservice course was offered to elementary teachers. During the winter and spring of 1979-80 there was enough demand to repeat this course three more times. As a result of these inservice courses some elementary teachers began to develop particular enthusiasm for using microcomputers in classrooms. These teachers became facilitators of microcomputer use in their schools, or "teacher buffs."

Since 1979 the number of microcomputers has increased rapidly. Funds have come from many sources. Some money has come from school budgets, or from discretionary funds. The Home and School Associations have provided funds for microcomputers in elementary schools. In one junior high school a state grant provided microcomputers for special education students. A principal has used an equipment fund that rotates annually among the secondary schools to purchase micros. As a result of this individual initiative there are now unequal numbers of computers in the schools. This inequity is a source of concern in the district.

All of these developments have been spurred by the enthusiasm of teachers, parents and/or principals who are eager to have microcomputers in their schools. Several of the elementary schools have teachers who have unofficially taken on a coordinating and facilitating role. In other schools, parents play this role. Each junior high school has a teacher who organizes computer instruction and computer clubs.

Recently, more formal mechanisms for the organization of computing have been created. In the summer of 1980 a steering committee was formed to develop and implement a seventh grade computer literacy curriculum. This committee included all of the junior high math teachers and the assistant superintendent for secondary instruction. It was succeeded by the current steering committee for computers in the curriculum whose goal is to create centralized policies and programs for computing in the district. It hopes to develop a K-12 computing curriculum. This committee is made up of the assistant superintendent for elementary education, the math coordinator and a teacher representing each school.

Software acquisition and development. Software has been acquired in several ways. It generally comes from such informal and/or inexpensive sources as Cursor magazine or teachers in other public school systems. Some commercial software, such as the Milliken math program, was purchased. There has been local initiative in software development. Approximately 12 programs were developed in Greenview during summer workshops. In general high school students play a central role in writing and altering programs at the

request of elementary school teachers. Software related to many areas of curriculum is available at both elementary and secondary levels.

A set of tapes has been collected and duplicated to accompany each Pet. High school students working with the coordinator of computing are responsible for updating these tapes. Two teachers and the math coordinator produced a catalogue of Greenview tapes which describes each program, recommends grade levels, and classifies software according to Bloom's taxonomy. Teachers who have the ideas and skills to create new programs can be employed during the summer to produce new software for the district.

Use, values, intent. When microcomputers were introduced, there was no unified set of values or rules for their use. The prime intent of the Board of Education and of district administrators was to develop a computer-literate school population. They were willing to give schools time to explore before setting any specific policies and expectations.

The general strategy was to put microcomputers into schools, provide opportunities for teacher training, and hope that someone would become enthusiastic and take responsibility. In some schools this happened, and in others it didn't. For the most part, principals did not initiate using the computer, but responded and accommodated to interest from teachers and/or parents. In one school the microcomputer program has grown despite initial resistance from the principal, because of the enthusiasm of parents.

There is an intentional effort now being made to disassociate the computer from its exclusive tie to the math curriculum. Mathematics teachers at the high school and junior high school levels initiated the use of micros and taught the first set of inservice courses. In addition, planning for the seventh grade computer literacy course included only mathematics teachers. However, in this curriculum teachers in every discipline are to teach about the roles computers do or might play in their field.

Elementary Level

Features of the Microcomputer Program

Demographics and personnel. Five of the seven elementary schools in the district were visited. In four, we spoke with administrators, teachers and students and observed classrooms. In the fifth, we spoke only with the principal. The schools were similar in terms of populations served.

In four of the five elementary schools visited, fifth or sixth grade teachers are responsible for the management of computer use. Computers are moved around the school according to a schedule developed by a managing teacher. In the fifth school there was no one person responsible for scheduling. A sign-up sheet in the hallway was used. In most schools teachers can use one or two micros from one half to one full day each week.

Typically, the teacher who manages the schedule is also the microcomputer support person--the person whom other teachers seek out for advice and help. We have dubbed these individuals "teacher buffs." While they differ in training and interest, they share a commitment to microcomputer use in schools. There is no monetary or time compensation for their computer-related work. These teachers are involved, active, knowledgeable and enthusiastic about what they do. They help and encourage other teachers to use microcomputers as well as expand their own expertise. All of this requires committing a great deal of personal time - before school, on weekends, and during vacations. Such time is given willingly. In these schools, there is at least one other person who is also actively involved with and knowledgeable about computers. In some cases this person is a teacher, in other cases a parent-volunteer.

Training/support. Training is the primary form of support. Teachers who take training related to computers, either through inservice courses or outside institutions, earn incremental salary credit. However, approximately 45 percent of the teachers in the district are already at their maximum salary levels. Salary increase, therefore, is a motivation for training for only some of the teachers.

Equipment. All 23 Pet microcomputers in the elementary schools are on movable carts or desks. Each comes with a library of tapes. In some schools these tapes are color-coded to match the machines they accompany, or to indicate levels of difficulty or curriculum area.

Resource distribution. Since microcomputers are a scarce resource in all schools, fairness of access is valued highly. There is, however, more use in the fifth and sixth grades than in the lower grades. Several reasons were suggested for the greater use in the upper grades. These include: (1) more software for older children; (2) the reliance on reading skills to operate the programs; (3) the relatively greater ease and independence with which the older children can run the micros; and (4) the assumption of some elementary teachers that advanced mathematical skill is important for using a micro.

Purpose and relation to curriculum. The purposes for which

teachers use the micros are varied. Some teachers are interested in children having fun and learning at the same time, an experience they believe micros afford. Others are interested in their students' feeling comfortable with microcomputers. Some are concerned primarily with skill development, while others focus on programming and problem-solving.

In general, we observed no clear connection between work with the micros and other classroom activities. In many classrooms, the microcomputer was another option for students during a choice time. Children observed doing drill and practice programs in math were not necessarily working in areas which dovetailed with current classroom instruction. In one classroom children were working on mapping skills as seat work and using related skills in a computer game. Yet neither students nor teacher seemed aware of the connection. The one application in which the relationship was clear was the use of a tachistoscope program that drilled students on their spelling words for that week.

There are several points of view about how the computer work should relate to the curriculum. One teacher carefully mapped out the following view of what should happen: First, a teacher should teach the concepts relevant to a certain area. Then she should use the computer program to give children an opportunity to try out their understanding of these concepts. Finally, the teacher should follow up with activities which generalize from the conceptual and computer-related activity. We did not observe whether the teacher who proposed this model actually uses it.

On the other hand, there are teachers who believe that computers in the classroom constitute the beginning of computer literacy. They feel that what is significant is not the content of the software, but rather that children learn how to use the machine and feel comfortable with it.

Some teachers hold an intermediate position that literacy is important, but that children can become literate by using software related to the curriculum. These teachers select programs with some relation to the curriculum, but not necessarily to what is currently going on in class.

An interesting feature of microcomputer software is that even if a teacher makes choices which mesh with classroom activities, in some programs children can override these choices. In a third grade class a teacher had recommended that the students use a particular level of a mathematics program. We observed one student selecting a more difficult level and working through the problems even though the concept - regrouping - had not yet been taught

in class.

A different model of use applies to special education students. Teachers of special education, required to develop Individualized Educational Programs under PL 94-142, are accustomed to thinking of their students' educational needs in highly personal and specific terms. These teachers have small classes and are skilled in managing very individualized instruction. They are accustomed to using sophisticated equipment for diagnosis and remediation. We observed that special education teachers carefully matched the computer activity with each student's diagnosed needs for skills development.

Source and use of software. In addition to the district-wide software, some teachers and schools purchase their own from materials budgets. In one school, the Home and School Association provided funds for the purchase of software. A resource room teacher purchased a set of Milliken tapes using the operating budget, but makes little use of them. She indicated that the more game-like programs are much preferred by the students. Skill-related activities with a game-like format are the most common application observed, for both special education and other students. Vocabulary, spelling and math are the most common areas of work.

In some classes children are assigned to work on the computer with programs the teacher has chosen. In others children may choose to use the computer, as well as select their program. While children sometimes work alone, they often work in pairs at the micro. Typically, children may use the computer only when they have finished their work in class. Only once did we observe a whole class having a lesson on how to use the computer. In this case the teacher was explaining the rules for using the machine and some elements or the BASIC language.

In one school a microcomputer is permanently installed in a resource center. Children assigned to the center for enrichment or reinforcement may opt to use the micro, or may specifically be directed to it. Their program selection is monitored by the resource room teacher.

Informally, in two schools children have access to the micros during lunch hour and after school in clubs. Such informal uses are usually under the supervision of the teacher buff. At these times children use the micros primarily to play games. These informal opportunities were created because of students' interest in having greater access to the micros, and because of teacher and parent concern about children playing games during school hours.

Microcomputers appear to be used equivalently by boys and

girls in elementary classrooms. We observed a total of 44 boys and 38 girls using computers.

Effects and Problems: Administrators

Effects. At this point microcomputers have virtually no effects on the elementary school administrator's role. Individuals have different levels of interest in and commitment to computer use in classrooms. Microcomputers have not yet become an integral part of their own work life.

Problems. Principals generally have little functional competence with microcomputers. Meanwhile, teachers and students are rapidly becoming adept with the technology. It is difficult for principals to exercise intelligent leadership under these circumstances. They find themselves turning to their teacher buffs for advice. This sharing of leadership is a problem for some principals.

Principals, even more than their staff, have limited time to learn new skills. Some have participated in the inservice courses for teachers.

Parents are pressuring principals for increased microcomputer-based instruction. Some of the pressure is covert and critical. One group feels schools are not meeting the needs of "rapid learners." Some of the pressure is overt and friendly. Parents volunteer to perform supportive functions. They teach small groups of students computer skills, prepare written materials and raise money for hardware and software.

Parents are neither able nor willing to raise all needed money. Principals, therefore, must find funds for microcomputer programs in order to satisfy the expectations of parents, students, and teachers.

Some principals question the amount of time needed for training teachers to use microcomputers successfully. They wonder if this is a good investment and whether other areas of curriculum will suffer because staff is placing too much emphasis on micros.

One principal expressed deep concern lest computer use undermine teachers' sense of their own ability to teach children. He worried that the presence of a "teaching machine" might lessen teacher productivity.

Looking to the future. Elementary principals seem to accept microcomputers as part of their schools' futures. While some would like as many as one machine in each classroom, most think about budget constraints and predict

smaller numbers. They want micros used for drill and practice in conjunction with existing math and language curricula and to enrich and extend thinking in such areas as social studies.

All principals are concerned about their responsibility for teacher preparation. One suggested that teachers be rewarded for becoming users of micros. Another expressed concern about the mental health and continued productivity of long-term teachers under pressure to cope with a complex innovation.

Two principals expressed concerns about the possibility that programming will become part of the curriculum. One felt that classroom teachers have neither the time nor expertise to teach programming. It must, he felt, be a pull-out program taught by a specialist. Another principal suggested that programming is too "detailed and specific" to become a requirement or the elementary curriculum.

Effects and Problems: Teachers

Effects. Although most teachers report no change, a number of teachers in Greenview feel that microcomputers have had dramatic effects on their role as teachers and on what happens in their classrooms.

Those who report changes mentioned that with the computer the children seem more in control of their own learning. Children make discoveries and report them to the teacher rather than waiting for the teacher to tell them what they "should" know.

Another teacher finds that because some students are absorbed with the computer, he can no longer continue the whole group teaching he had done earlier. He feels that he is getting to know his students in a new way and that social interaction between students and teacher is changing. Because the teacher and students are often equally new to microcomputers, they explore and solve problems together. He finds, however, that computers place extra demand on him in the classroom. He must match software to students' needs and keep yet another kind of record.

Relationships between students and teachers are changed by student experts who often know more than teachers do about computing. These students teach and assist the teachers. Teachers say that they enjoy having students do some teaching. No one said that they felt these relationships were threatening.

In terms of teachers' relations with each other, there is a great deal of peer teaching about computers. The teacher

buffs are in a unique position since they have expertise to share and are, on the whole, more than willing to share it.

Problems. Teachers reported many problems in connection with computing. Almost all teachers say they need more time to learn how to use micros, to preview programs and to plan for intelligent use of the technology in their classrooms. Another time problem of teachers is fitting microcomputers into the existing schedule. This problem increases when micro use is not part of the curriculum but is an "enrichment" activity.

Some teachers are not certain that the use of computers and related training is genuinely voluntary. In one school all teachers were required to take the inservice course. Some teachers feel pressured to use the computers because they feel it is the wise thing to do politically. It is clear to them that there is a great deal of interest in computing at the district level.

Teachers who are first-level users have technical problems which must be overcome before educational goals can be addressed. They are willing to learn how to use the machine and to make it run. But these teachers are dealing with survival and management issues (e.g., "how not to make a fool of myself in front of the children") and feel inadequate to judge software at this point.

It is the experienced users who are asking for more varied and sophisticated software. They feel that software is inadequate. They want more varied programs in areas such as social studies and geography. And they want programs which are not just drill, but which help develop problem-solving abilities. Yet conceptually challenging software is not available.

In general we found no strong opposition to computers among elementary teachers.

Looking to the future. All the elementary school teachers we interviewed are convinced that microcomputers are in Greenview to stay. Most foresee that there will be a micro available for every classroom, though some schools might place these in resource centers. One teacher believes that there will be parity in hardware among the schools.

Some teachers are aware that there will soon be a district curriculum for computing education, starting in kindergarten. Most teachers expect the micros to be used for extension and remediation of individual learning. One suggests that all fifth and sixth grade children be taught programming. Another thinks it important that all teachers be able to load, run and adapt programs, and that all children be taught to load, run and list them.

Several teachers see a need for more and better software, especially in such areas as creative writing, social studies, and science. One feels that, without this, the microcomputer will become another "passing fad." Some expect that the needed software will be locally produced. One foresees that local software will be sold to families who have microcomputers in their homes.

Effects and Problems: Students

Effects on students. Teachers had a number of reports about the effects of the micros on students, particularly in relation to social interaction and skills. One teacher deliberately teaches the more reserved children to use the Pets, and then has these children teach the others. He feels that these students gain in social skills, peer status, and responsibility as a result.

Several teachers stressed the possibilities for cooperation in working with the computer. Having to share a machine, they feel, helps children learn how to work together, to make joint decisions and to take different roles in working out a mutual enterprise.

For the most part, teachers felt it was too soon to make statements about academic gains attributable to the computers. In one school, however, a principal reported that math performance went up in the fifth grade as a result of emphasis on math with the computer. One teacher reported improved spelling scores in a sixth grade class. A first grade teacher felt use of the keyboard contributed to manual dexterity and hand-eye coordination. Another sixth grade teacher felt the "infinite patience" of the machine was supporting the learning of his slower students.

Problems of students. The most common problem for students was having enough time and access to the micros--the ever-present problem of limited resources. Some students solved this by joining informal computer activities either at lunch time or after school. But in some schools teachers were unable or unwilling to provide informal access.

Teachers' lack of competence with the technology is another problem for students. When something goes wrong, the classroom teacher may not know how to correct it. This may mean waiting for the local teacher buff. Such waiting can be frustrating to students, as it reduces their opportunities to use the micro.

Teachers' choice of programs is sometimes disagreeable to students, especially when these are undisguised drill and practice. We observed, however, two sixth grade girls

accept a program they criticized as boring, and even go through it a second time, just to use the machine.

Students sometimes do not understand the point of a program. We observed two third graders using the simulation, "Lemonade Stand," which requires manipulating economic variables. They made entirely random choices and had no sense or how their choices affected the outcomes. They needed, but did not receive, guidance in noting the relationships among variables in the simulation.

Secondary Level

Features of the Microcomputer Program

High school. In the high school micros are housed in a computer resource center. Student programmers develop instructional programs requested by elementary and junior high teachers. In addition, micros are used in some programming and math courses to introduce students to terminals. Most high school computing is done on the PDP-11 and its 14 terminals. Because microcomputers are used minimally in the high school, this section focusses on the junior highs.

Demographics and personnel. Of the two junior high schools in Greenview, Abraham Lincoln is much smaller than Andrew Jackson in its physical plant, although it has only about one hundred fewer students (approximately 650 compared to 750). Andrew Jackson is larger, newer, and closer to the high school, which may account for its greater interest in computing.

In Andrew Jackson Junior High School the computing teacher and leader is a math teacher with 12 years of computer experience. Another math teacher who came to the school with computer training and a knowledge of Fortran also teaches computer science. Most of the math faculty is interested in developing computer competencies, as are many teachers from other disciplines. Special education teachers regularly use microcomputers as teaching tools.

In Abraham Lincoln Junior High School it is also a math teacher who is the major computing teacher, school enthusiast and leader. The special education teacher uses micros regularly with her students. Teachers in some other departments are developing an interest in micros for their subject areas.

Training/support. There are several ways in which interest in computer competency is supported among the Andrew Jackson faculty. First, the teacher buff has as one of his goals to help others become independent users of the technology. To this end he has offered in-school training

courses which have been attended by about 25 percent of the teachers. He also is in charge of arranging class visits to the computer resource room. He is assigned one period a day for this work. He spends another period a day developing and supervising a program for learning disabled students who use microcomputers to learn mathematical concepts and operations. Secondly, the principal is committed to promoting and expanding microcomputer use. He has a carefully developed five-year plan for acquiring enough microcomputers to place one in the workroom of each major academic area. He is actively promoting the use of microcomputers in all subjects. Finally, a group of highly competent students develops programs for teachers who need software in order to use computers in their classes. These students are supervised by the teacher buff.

In Abraham Lincoln the teacher buff makes himself available to other teachers on request. He teaches them how to use the machines and writes programs for them. He is responsible for scheduling and supervising the computer room. He is assigned one period a day for these computer-related activities. The principal facilitates the work of the computer specialist and recognizes the need for expansion of computer use into all subject areas. The school, however, does not have a plan for such expansion. The principal does not want to impose an innovation on teachers, although he would be responsive to initiative from them. He feels he must set an example by becoming computer literate and learning programming himself.

Equipment. The district's policy is to maintain parity in resources and equipment between the two junior high schools. Each school had equivalent funds to purchase microcomputers. The Andrew Jackson school has three 48-K Apples with disk drive and a printer. The Abraham Lincoln school has three Pets in its computer room and two Pets which the special education teacher obtained for her program. Each school has four terminals to the PDP-11.

Resource distribution. Both junior high schools have rooms which house the microcomputers. In Andrew Jackson, this is a regular classroom in the math department. In Abraham Lincoln the computer room is much smaller than a typical classroom. The special education teacher in Abraham Lincoln keeps her microcomputers in her own resource room.

In both junior high schools the microcomputers are used regularly to teach computer literacy, computer science, and programming. These classes meet in the computer resource room. In both schools teachers of other classes also incorporate microcomputers in their teaching. They are used extensively for mathematics, especially with low-achievers. Teachers of other subjects use micros on a limited basis as another mode of instruction toward

particular goals. In Andrew Jackson they are also used for instruction in social studies, biology, vocational education, reading, and as a Language Lab tool for foreign language study. In Abraham Lincoln, the biology and social studies teachers have used the minicomputer in the past, and are interested in learning to use the microcomputers. In both schools, teachers must arrange for their classes to go to the resource room to use the micros, so the procedures for including micros are rather complex.

In the special education programs the goals for microcomputer use differ somewhat in the two schools. In Lincoln the emphasis is on improving motivation, socializing with peers, and enhancing self-concept. In Jackson these goals are salient, but there are also specific instructional objectives. Students keep track of their work on the computers and of the programs they use.

Source and use of software. In both junior high schools there is some in-house production of software. Lincoln uses the district software for Pet computers. Jackson, because it has Apples, must use other software. At Jackson, some software has been purchased with state and federal monies for vocational education students. A state grant for using micros with learning disabled students is supporting the production of new software by the computer specialist and three students. When teachers request a program in Jackson, it is often developed by students in the ninth grade programming class.

Microcomputer software is used for drill and practice to remediate and reinforce skills, for simulations, for data analysis, for games as a reward for completing drills, and for testing.

Both schools have after-school clubs. In Andrew Jackson the two clubs are for programming, one for seventh graders and another for eighth and ninth graders. In Abraham Lincoln the two clubs are for games.

Despite the many opportunities for junior high students to learn about micros, there is overwhelmingly male participation in elective situations, formal and informal. The classes we observed were populated by a total of 79 males and 31 females, or a 2.5 to 1 ratio.

Effects and Problems: Administrators

Effects. With increased use of micros in the schools and a computer education curriculum under development, school administrators feel they must become knowledgeable. One assistant principal is being instructed by a student and is also taking a machine home with him on weekends. A principal acknowledged, "I must be the agent of change. I

need to be the model in literacy. I should know programming."

One assistant principal reported that he would soon receive a Pet to be used for creating a master schedule and entering cumulative student data. A principal hoped he would have one for tracking pupil progress which he could then report to parents.

Problems. Administrators are aware that many students are entering the secondary schools with computer competencies. They are concerned about how schools will meet these students' needs for more advanced and varied computer uses.

In response to these needs, school administrators want to find ways to extend computer literacy to faculty in subject areas other than mathematics. They anticipate resistance from some staff members and differences of opinion as to where initiative for this retraining should come from. Administrators feel the need to develop a broad base of computer leadership. The energy and expertise of single computer buffs can go only so far.

Administrators are confronting problems of reallocating funds, space and personnel time as they build an expanded computer program.

Administrators recognize that they must become computer literate in their own work. They will use the administrative minicomputer for recording attendance, for pupil data collection, and for budget construction.

Looking to the future. Secondary school administrators believe that microcomputer use will expand in their schools as the community continues to press for more computer training. Yet their plans and expectations differ widely.

One has a well-developed plan for acquiring and using micros in all academic areas. Another would like to buy three micros each year for science and math, but thinks it unlikely the district will fund this plan. A third would prefer teachers to take the initiative, and is opposed to forcing them to accept equipment they do not want. Another plans to capitalize on the interest of one individual per department and have the computer coordinator train that person.

One principal foresees that more basic skills will be taught by computer, allowing teachers to individualize the curriculum more. A second would like to create a microcomputer center (a two-room lab and lecture facility) that could accommodate two classes at one time. Another foresees that some traditional electives may have to give way to new options in the future.

Effects and Problems: Teachers

Effects. Teachers who use computers enter into new relationships with students who are proficient users - they are colleagues rather than teacher and student. Teachers seem comfortable, even pleased, to have students who can be instructors and trouble shooters when computers are being used. They are willing to learn from them. The general dynamic of the classroom is changed because teachers lack experience and competence in this area, and learn along with and from their students. There is less formality and more genuine problem solving. Some high school teachers thought that other teachers might find their own lack of competence threatening. However, none of the junior high school teachers we interviewed found this new relationship with students problematic or thought other teachers would.

Problems. Access to the machines is a problem for teachers in both junior high schools because of their location. In Andrew Jackson all the computers, micros and terminals, are in a room which can accommodate an entire class. However, this room is used for math and computer classes. If another teacher wants to use the computers, arrangements must be made two weeks in advance because the computer room class must move. One teacher resigned her position in part because her students could not have access to computers as often as she thought desirable.

In Abraham Lincoln the micros and terminals are located in a computer room too small to accommodate a whole class. This creates difficulties of supervision for a teacher who must split a class in order to have some of the students work on the computer.

The new computer literacy course required for seventh grade students has created a problem for some teachers. There is an insufficient number of adequately prepared staff to teach the course. Therefore, some of the instructors are novices when it comes to computers. They fear that their teaching will be evaluated in an area in which they do not feel comfortable.

Some teachers do not see how microcomputers fit into the goals and values of their program. One teacher was suspicious that the new technology might be expected to produce "magic solutions." Perhaps higher student achievement would be demanded because of this "new gimmick".

There is a lack of appropriate software for many subject areas. Teachers unfamiliar with the technology sometimes have unrealistic expectations of what programs can be created.

Looking to the future. Secondary school teachers predicted an increase in the use of micros in all subject areas. They saw this happening gradually, not as a sudden "revolution". Several predicted that each math class is likely to have its own micro. They think micros will figure importantly in science and vocational education.

Teachers anticipated learning to use micros for recordkeeping, for tracking test scores, to reinforce basic skills through drill and practice, for simulations, for graph construction, to teach computer repair and maintenance, and for their motivational value. One teacher worried that if micros were used excessively they would lose their motivating qualities.

Teachers expect that secondary offerings will be revised as students learn computer skills at an earlier age both at home and in school. One suggested a computer science course for ninth grade students. Another wanted to write programs for science courses if he could be given the time. Others predict that programs now on the PDP-11 will be adopted for use on Pets.

Teachers vary in their views of district commitment to microcomputers. One believes that salary increases will compete for funds that could be used for computer activities. On the other hand, some predicted that there will be a full-time position for computer development in the junior high schools.

Effects and Problems: Students

Effects. Secondary teachers reported social and personality changes for some students who use computers. A number of teachers mentioned that the chance to work on a computer is highly motivating to many students. Successful mastery of the machine resulted in visible changes in some students' self-concept. These effects were observed in both compensatory and regular classes. Teachers of learning disabled classes mentioned that the step-by-step organization and sequencing of computer software was helpful to their students. Some of these students paid more attention to the computer than to a human instructor, in part because of its impartial reaction to both their errors and their need for many repetitions. Teachers reported that learning disabled students improved their social skills by working in pairs on the micros.

Teachers indicated that there were students who knew more than they did. Yet none spelled out how this status affected the students who held it. We assume this was a positive, important role for these students. Good programmers are not always the most outstanding students. Therefore, working with the computers may be a way for them

to attain special status with teachers.

The students we spoke with felt that they could learn some material quicker from a machine than from a teacher. They enjoyed going ahead and working on material not yet introduced by the teacher. On the other hand, they felt that they learned more from the teacher than from the micro, because the teacher "gives longer explanations." When they work on the machine, however, they feel free to ask for many repetitions. To do so of the teacher, they say, would be embarrassing.

From our classroom observations we noticed that students were very involved in the programming classes. In one case, when a teacher switched from lecturing to actually running a program, the whole class became more attentive. In other cases, students in a programming class ignored the bell at the end of the period. Indeed, the teacher reported that it is often difficult to get students to leave the class because of their high level of involvement.

Problems. The primary problem for students is getting access to the machines. The group of students which is most involved uses the computer room before and after school.

District Level

Effects and Problems: District Administrators

Effects. The initiative for microcomputers has been largely at the grass roots level, coming from parents, children, and teachers. District administration has found itself forced to pay attention, because of the widespread interest, to something that might not otherwise have been a priority.

Problems. The major problem for district administration is articulating and resolving the divergent views within the system about microcomputer education. Issues include whether the computer should be used for individual or group learning, whether the computer itself is a curriculum, a tool for other curricula or a motivational device, and whether there are developmentally appropriate computer experiences for children of different ages.

While this policy-making process is taking place administrators are concerned that existing uses be controlled before they become too entrenched.

There is a problem of how to relate current practice to future policies. For example, Home/School Associations have been providing micros to elementary schools. Yet this has contributed to inequities which the district may wish to correct in the future.

Indeed, the question of the present inequitable distribution of hardware is a difficult one. Should each school receive the same number of micros from the district? Parents may feel that their contributions should not influence the district's contribution even if that perpetuates inequities.

Funding is a problem, especially since long-range planning did not anticipate such rapid microcomputer development. Not all taxpayers regard microcomputers as necessary in elementary schools. They may rebel against program costs in the future.

Another budget problem is how the district can keep up with rapid changes predicted for the technology. There is concern that today's investment in technology may be outmoded tomorrow. Questions about what to buy and when are not easily answered.

Looking to the future. District administrators expect interest in microcomputers to continue and expand. They expect the increased use of microcomputers to be influenced primarily by cost factors. One administrator anticipates a micro in every classroom, but can see the possibility of as many as six if prices decline.

District administrators realize that the new seventh grade computer literacy program will shortly become obsolete as elementary students work more and more with micros. They see the need for more elective programs in the secondary schools. They expect micros to be used for problem solving in physics, biology, social science and chemistry, and for "straight forward, boring stuff," such as skill improvement. They want to establish a well-articulated program that allows students to be either or both consumers and producers of software and that takes developmental factors into account. The major goal will be that every student in the system become computer literate. To achieve this goal they will give priority to staff development over hardware acquisition.

Issues from Greenview

There are many issues raised by the microcomputer implementation in Greenview. Those which are most central are discussed here.

1. How much microcomputer-based instruction will the district be able or inclined to support? The growth thus far has been rapid. However, budgetary constraints and competing programs may limit funds for future growth. Yet there are needs of students, teachers, and parents to be met.

2. Should the inequity of hardware in schools be righted? The inequity among schools has resulted because the acquisition of hardware has relied heavily on local initiative. Were the district to right the inequities, there could be resentment by those who have worked hard to bring computers to their schools. Whether creating equity in equipment would create equity of program and enthusiasm is another question.

3. How can Greenview obtain or produce suitable software? There are teachers and students in the district who have the expertise to produce software. Should these people be given time to create the software local teachers are requesting? Is this the most reasonable plan for creating the kind of software teachers want?

4. In terms of training, there are several questions. First, what constitutes adequate preparation? Though Greenview provides formal training and teacher buffs give informal help, many teachers require more time to be comfortable with microcomputers and to use them intelligently.

A second question is whether such training should be voluntary or involuntary. Those teachers who were required to include computer training in their professional improvement plans resented it. The question then becomes what is the impact of training which is involuntary.

5. A very basic issue is what is the relationship between the computer and the rest of the curriculum. Whether the study of the computer itself constitutes a curricular area or whether the computer is a tool to be used in several areas is a frequent question, and one without an agreed-upon answer in Greenview.

6. Another issue is where the computers should be located in a school. Several different models--classroom (i.e., movable computers), learning resource room, computer room--are in operation currently, and people disagree as to which is most beneficial. Location is integrally related to

issues or student access.

7. Which students are served by the microcomputers? In elementary schools, students at all achievement levels and of both sexes have access to and make use or the micros in both formal and informal situations. In the junior high schools, however, the students who use the micros most are special education students and those electing advanced math and programming courses. This pattern tends to leave out average students and girls, a trend which is perpetuated in the high school.

8. Student expertise poses two kinds of questions. First, can the system respond to their pressure for more courses? As students are learning to program, at earlier and earlier ages, they are asking for more advanced courses. In the long run, other curricula - such as mathematics - may be affected by the skills students have and need

The other side or the coin of responding to pressures created by student expertise is making use of that expertise. One can imagine a system which makes extensive use of computer-competent students, both for software production and for teaching. Students are currently being used in both ways in Greenview, but informally and on a small scale.

9. Another issue is whether microcomputers will affect patterns of interaction in the classroom. Will the interaction children have with each other around the computer alter modes of interaction in the classroom? Will students spend more time working cooperatively on problems and projects, using the teacher as a resource person? Will the presence of microcomputers change the pattern of whole-class teaching as the technology makes it easier for children to work individually or in pairs?

10. How will schools adapt to students' having micros at home, as some already do? Some administrators and teachers are thinking about ways or making a connection between school and home uses. But home-owned computers may create inequities because some children will have opportunities for advanced learning. These children may put pressure on the school system as a result of their expertise.

Update

Since our visit to Greenview there have been several new developments with respect to microcomputers. New microcomputers have been purchased, and plans have been made for additional 1981-82 purchases. During the 1981-82 school year the district hopes to have a total of 32 micros in the elementary schools, 15 (or more) in the junior high schools, and eight in the senior high. The senior high and

one junior high school have each purchased printers.

During the spring of 1981, seven additional inservice microcomputer courses were offered. A 1981 summer workshop is planned for the development and evaluation of software, as well as the production of users' guides.

Administrative uses of microcomputers are increasing. The high school's assistant principal took a PET home on weekends to work on scheduling. As a result of this work, high school students received their schedules early, and the administration, from its own funds, purchased two PETs for administrative uses.

CHAPTER FIVE

CONCLUSIONS

We have investigated three different innovations which reflect their school systems. School systems assimilate microcomputers to their own goals, needs, and ways of operating. Clearly Salerno would not have a Granite-style innovation, nor the other way around.

On the other hand, each system is now experiencing or is likely to experience changes resulting from this innovation--new staffing patterns, new roles for teachers and students, new sources of curriculum. If there is a microcomputer revolution going on, it takes different forms in different contexts.

Research on the implementation of educational innovations has, in the main, examined the factors that influence the extent to which actual use of an innovation matches its intended use (Fullan & Pomfret; 1977 Miles, 1964). The study of microcomputer implementation in schools requires a different approach, however, because one of the important tasks of educators is to define how the machines will be used. A central concern of the present study, therefore, was to examine how decisions about use were made and how patterns of use developed. For us implementation was more a process of adaptation than of replication (Berman & Pauly, 1975).

At each site, issues were revealed which could be the basis for a program of research. From our perspective, however, there are a few cross-site trends which raise questions and highlight issues of critical import. These are the issues and questions which we think constitute a future research agenda. In this chapter we will discuss these trends and, where appropriate, draw on the existing literature to clarify and support our points. The six trends which raise important questions for research are:

* The differential access to the microcomputers
* The emergence of new roles in response to the microcomputers
* The lack of integration of microcomputers into elementary classrooms and curriculum
* The inadequate quantity and quality of software
* The inadequate preparation of teachers for using microcomputers
* The lack of knowledge of effects and outcomes of the

instructional use of microcomputers.

The Differential Access to Microcomputers

In all sites we observed differential access to microcomputers. This was true at both the elementary and secondary level. At the elementary level in Salerno the differential access was deliberate, since the machines are used to improve the performance of students below grade level. Government funding limits who may use the machines.

We wonder what will be the long-term outcomes of limiting microcomputer use to students who need remediation. Will the microcomputer in grades kindergarten through eight be seen as a machine only for children who are not doing well? One Salerno middle school teacher stated that there is a stigma attached to using the microcomputers. He refused to have any in his classroom as a result.

The other two sites valued equity of access at the elementary level. Very few machines were restricted by policy or funding to specific groups of students. However, since both sites have depended largely on local initiative, there is an unequal distribution of microcomputers among schools. This gives some students greater access to computers than others, based upon what school they attend. We do not think there were systematic differences between the "have" and "have not" schools with respect to student populations. But clearly this possibility needs to be anticipated and studied. A local initiative model of innovation could unintentionally result in differential access. If schools, for example, rely on local PTA monies for the purchase of hardware, then schools in poorer communities could have much less access to computers than their more well-to-do counterparts. On the other hand, the literature on educational innovation makes clear that community involvement increases the likelihood that an innovation will take hold in a school (Miles, 1964, p. 640, 645).

At the secondary level there was differential use based on a number of dimensions. Sex was the most obvious. Starting in seventh grade, when the microcomputers moved out of classrooms and hallways into math and business departments, there was much greater male representation among students who used the micros. This is not an issue of access per se, since girls are not systematically excluded from using computers.

It is, of course, too early to tell whether those girls who have learned to use microcomputers in elementary school will continue to use them in junior and senior high school math departments. If they do, then the microcomputer

innovation may be responsible for profound changes in some sex-differentiated secondary school courses. If not, then the microcomputer may well become a part of the intimate connection between males and math which already exists in our schools. It is important to look carefully at this aspect of microcomputer use.

At the secondary level there was also differential access to computers based on ability. In Salerno, the students we observed in a high school programming course were all described as "good in math." In Greenview, microcomputers were used primarily for two groups of students--those who were skilled enough to take computer math courses, and those who were learning disabled. In Granite there was a preponderance of elective computer math courses at the senior high school level. It would appear that, if anybody is being left out of the computer experience based on ability, it is the average student.

It is possible that differential access to microcomputers will disappear when they are no longer scarce commodities. On the other hand, one can imagine current trends contributing to a future in which levels of achievement determine what students are permitted to do with computers. Less able students will use computers for drill and practice, while the more able will learn to program. The educational assumptions behind such a divison of applications, as well as the likely educational outcomes, need careful examination.

The Emergence of New Roles in Response to Microcomputers

In all of the sites we saw new roles emerging in response to the microcomputer. The first is that of teacher buff. Teacher buffs are teachers who are not only interested in and knowledgeable about microcomputers, but play a central role in spreading the innovation. They give a great deal of personal time to teaching and encouraging other teachers, for little or no compensation. There are many questions to ask about the teacher buffs.

First, we saw teacher buffs in Greenview and not in the other sites. Are there unique features in the Greenview innovation which make it possible or even necessary for buffs to emerge? In terms of how microcomputers were used, there was great similarity between Greenview and Granite, yet only in Greenview did we see teachers who tried to spread the innovation to other teachers. Could the size differences between the school systems, the greater ease with which teachers in Granite could obtain hardware and software, or the placement of microcomputers in media and resource centers in Granite, account for this difference? Alternatively, perhaps teacher buffs emerge at a certain stage of any innovation. Perhaps next year they will be

found in Granite and Salerno.

In terms of the future of teacher buffs, we wonder how long they will continue at the present pace before they burn out, leave the system for more lucrative positions in industry, or have their roles institutionalized. The literature on educational innovation suggests that "enthusiasts" are rarely placed in positions of authority in school systems (Miles, 1964). It is not clear whether the teacher buffs are identical to the "enthusiasts" referred to. Whether these individuals take on more responsible positions in schools, however, is not as important as whether the services they perform are institutionalized. The sociological literature on institutional change suggests that this should happen (Gross, Giacquinta, & Martin, 1971).

Finally, it is important to determine whether the teacher buffs are a necessary component of effective innovation. Does an innovation take hold only when there is a certain amount of grass roots missionary zeal, or can it be just as successful when it is centrally planned and resources are widely distributed, as in Salerno?

A second role which has emerged is that of the student expert. These experts, found in both Greenview and Granite (and, we assume, although did not observe, in some Salerno high schools) are significant in two ways. First, they play an instructional and collegial role vis a vis teachers and students. Second, they are now making demands of the system. Their need for more courses and better-trained teachers poses problems which schools must solve.

Student experts are unique in their relationships with teachers. First, they instruct teachers in computer-related skills. Second, they work with teachers collegially on computer-related activities. Third, they create something which teachers want--software for their classrooms. Teacher-student relationships like these are unusual in elementary and secondary schools. Yet they seem likely to expand because of the rapid growth of student expertise relative to that of teacher expertise.

It is important to know, then, whether these new student roles will continue. Are we witnessing a change which will end as teachers become more expert, or a permanent change which reflects the impact of the technology per se? What kind of impact does this new student role have on teachers? Some teachers were very positive about this new development, while others were concerned lest other teachers feel threatened.

A different question is how schools make use of the wealth of student expertise they are helping to create. Will

students be used extensively for local software development? Will they be given more formal teaching roles in computer courses?

Student experts are placing demands on school systems for more computer-related courses and more advanced offerings at increasingly lower grades. This represents a unique source of curricular change. According to Matthew Miles (1964, p. 633), the main shaper of secondary and elementary school curriculum is the college curriculum. Higher education tends to assume and require a certain kind of training at the lower levels. With the advent of the student expert, however, we have exactly the reverse situation. Student expertise is reshaping and accelerating the elementary and secondary curriculum. As a result, colleges will soon have to expand and accelerate their computer offerings to accommodate the expertise of incoming students.

The Lack of Integration into Elementary Classrooms and Curriculum

The relationship of the microcomputer to the curriculum has emerged as one of the most complex issues in our study. A central concern throughout the research has been whether the computer work was integrated with classroom curriculum. On the elementary level we found computers physically separated from classrooms and/or not part of the ongoing classroom work.

In Salerno the computers were not in elementary classrooms, but the work on the computer shared the objectives of the classroom curriculum. It is important to study whether children can relate their work on microcomputers to what they do in the classrooms, given that the related activities occur at different times, in different places, and with different teachers. In Granite microcomputers were not in classrooms, and were not usually integrated with classroom work. In Greenview microcomputers were in classrooms, but were not well integrated with the curriculum.

We would like to know whether bringing the microcomputer into the classroom is a necessary step in integrating it with the classroom curriculum. From our observations, it would appear that such integration is likely to take place only if classroom teachers actively work towards it. Clearly the task is not an easy one. What kind of support and knowledge do teachers need in order to integrate classroom work with microcomputer activities? Is the teacher buff an essential resource for making this happen? It is interesting that the site in which microcomputers were in elementary classrooms is also where there were buffs.

Our focus on the integration of the computer into the curriculum stemmed from our assumption that such integration was a measure of the impact of the microcomputer. Perhaps a better measure, and a more interesting question, is whether the microcomputer is actually changing classroom curriculum and activities in any way.

In none of the sites were micros intended to change or replace existing curriculum. In all cases they were to be additions to the ongoing curriculum. Either computers complement what is going on in the classroom or they comprise an additional curriculum in and of itself (i.e., computer literacy, computer programming).

In Salerno the microcomputer is affecting the curriculum because the software design group is essentially writing curriculum for the district. As guidelines, this group uses the baseline objectives established by the district, along with state-adopted textbooks. During our visit to Salerno we watched software developers take a stated objective (e.g., students must know the difference between fact and opinion) and write software to teach it. First they had to determine what fact and opinion were, and then translate their ideas into an instructional program. At each step they made important instructional and curricular decisions which would eventually affect large numbers of teachers and children in the district.

In Granite and Greenview it is not clear whether the computer is having any impact on the curriculum. What seems to be happening, however, is that classroom organization is changing. Many teachers indicated that classroom use of microcomputers resulted in a more individualized relationship between teacher and student, and less whole group teaching.

How the microcomputer can effectively be integrated with classroom curriculum is not clear. It seems likely, however, that the process of integration will also be one of change. It is not merely a question of putting two matching pieces - a curriculum and a computer - together. Rather, it is one of actively molding the pieces so that they can go together.

The Inadequate Quantity and Quality of Software

Teachers in Granite and Greenview felt that there was not enough software in non-math areas. How much software is enough? What kind of selections do teachers need? What makes some software useful and some not? Even with a dearth or software, not all of it is used. The curriculum innovation literature suggests three factors which may

contribute to use - accompanying materials, comprehensive curriculum, and teacher input.

Curricular innovations are more successful when student and teacher materials accompany the curricular materials (Miles, 1964, p. 636-637). Moreover, explicitness promotes implementation (Fullan & Pomfret, 1977). All of our sites provided teachers with information about what software was available. Only Salerno, however, had information on how to use it. Explicit instructions or suggestions for actual classroom use of software will probably contribute to its adoption.

A second factor contributing to curriculum use is availability of comprehensive, whole units (Miles, 1964, p. 637). Clearly this is the assumption behind the development which is taking place in Salerno. On the other hand, adoption of an innovation is less likely if it is seen as a threat rather than as an addition to what currently exists (Miles, 1964, p. 638). It is possible, therefore, that the introduction of whole curricula would be seen as threatening, rather than as appealing, by teachers. It is important to note that, as comprehensive as the Salerno software is, it was introduced solely to serve a remedial function primarily outside of the classroom.

A third contribution to the usefulness and adoption of software may be whether teachers have any input to its development. There is a long history of debate in the educational innovation literature about the extent of participation of teachers in the planning of an innovation. ("Planning" can refer to curricular design, materials, and/or implementation.) Proponents say that an innovation will not be effective unless teachers have a planning role, whereas opponents claim such a role is not critical (Gross et al, 1971). Software, unlike textbooks, is unique in the local possibilities for its design, development and modification. It, therefore, provides a field within which these points of view can be tested.

In Forest Hills, a Granite suburb, there is a local software development operation which relies heavily on teacher input and testing. The experiment has generated a great deal of enthusiasm. It would be interesting to compare software use here with a comparable district where there is no teacher input. Modification of software is another form of teacher input which should be examined in relation to teacher use and adoption.

The question about software which is perhaps most critical, yet most difficult to address, is that of quality. What is good software? Teachers in Granite and Greenview told us that they want better quality software. But neither

teachers nor developers at any site were able to state explicitly what makes good software.

What seems to be needed is a body of theory and research about software. We need models of how ideas can be realized in the software medium, along with research about how different types of software meet different educational goals and purposes and relate to different outcomes. To conduct such an ambitious undertaking would require synthesizing knowledge about instruction, learning, development, perception and media.

The Inadequate Preparation of Teachers for Using Microcomputers

In both Granite and Greenview teachers felt inadequately prepared to use microcomputers in their classrooms. In both sites there are inservice courses, opportunities for study in nearby colleges and universities, and helpful teachers and/or computer resource personnel. Yet these resources are inadequate.

Interestingly, teachers did not seem to want more or different courses. What they wanted most was more time to use the machines, to review available software and plan for its use in the classroom. They also wanted time to observe their students so they could better understand their students' learning styles and assess how the machines could be used. Many teachers mentioned that, in order to use the computers effectively, they need more time to plan for individualized use in their classroom.

What kinds of knowledge and experience do teachers require in order to use computers effectively in their classrooms? Actual operation of the machine is only one component of this knowledge. It is important to study which components are necessary for adequate preparation of teachers for different purposes. One would need to look at both formal sources of knowledge, such as courses and workshops, as well as informal, such as contacts with teacher buffs and time spent working at the machines. An important issue is whether teachers can feel comfortable with computers without any knowledge of proramming. Clearly the direction of the more involved teachers in both Granite and Greenview is to learn some programming.

The research literature on teacher training and involvement emphasize stages of concern, trainer-trainee interaction, incentives for staff development and the role of the principal as important factors to consider. The preparation needs of teachers can be expected to vary depending on their stage of knowledge of and interest in microcomputers. The literature on stages of concern (Hall, Wallace, & Dossett, 1973) makes clear that effective training requires

an appropriate match between type of training and teacher expertise and interest. Given the tremendous variability in teacher knowledge of and interest in microcomputers, effectively individualizing teacher preparation is not a simple task. Teacher buffs may be important because of their ability to give individual help to other teachers.

The kind of trainer-trainee interaction which is most effective is that involving two-way feedback (Fullan & Pomfret, 1977; Gross, et al, 1971). An implication here is that teacher buffs may play a critical role by being "on the scene" and able to give feedback to teachers as they are using the microcomputers and experiencing problems.

Because teacher preparation to use microcomputers, as to learn any new skill, involves a personal investment of time, energy and emotion (House, 1975), it is important to examine the incentives for such an investment. Lack of time and energy is frequently cited by teachers as a barrier to more effective implementaton (Charters & Pelligrin, 1973; Berman & Pauly, 1975).

Time seemed to be a critical issue for many teachers we interviewed. Some wanted more personal time to develop their computer expertise, while others wanted a school resource person to have more time to meet school-wide computer needs.

Given the absence of palpable incentives for computer expertise in our sites, it is important to study the intrinsic factors which account for teachers' interest and commitment. It would be interesting to compare sites with and without formal incentives to determine whether such incentives affected extent of teacher preparation and expertise.

Another form of support for teacher preparation is the role of the principal (Fullan & Pomfret, 1977). We found that principals in general were informed about the use of microcomputers in their schools. Many of them took an active role in securing funds for purchasing hardware or software. Ways in which principals accommodate to teachers' needs for time to learn about microcomputers is an important area for further study.

Lack of Knowledge of Effects and Outcomes

No one really knows what the educational or developmental consequences of using microcomputers are for children. What teachers report are primarily the social outcomes related to interaction, status, and self-esteem. That teachers in all sites made such comments clearly targets this as a rich area for study (see also Quinsaat, 1981). On the other hand, that no one knew what children were learning by

interacting with the microcomputers targets this as a critical area for study.

During the early stages of an innovation, teachers are often relatively unconcerned about student outcomes. Teachers' attention tends to be focused on their own skills in implementing the innovation (Hall, Wallace, and Dossett, 1973). There is a shift to more concern with outcomes as teachers become more skilled with the innovation. In general, teachers were not very concerned about outcomes. There seemed to be the implicit assumption that, were one to measure outcomes, they would be positive. With microcomputers one would expect concerns about outcome to vary with the clarity of purpose of the implementation as well as with teacher skill. In our sites, most concern for outcomes was expressed in Salerno, where particular outcomes have been planned for and expected. At the other sites, there was less agreement about what the computers were for, and thus less clear expectations about outcomes.

The microcomputer innovation is being fueled by a great deal of enthusiasm. The conviction is that the microcomputer is a good thing. Yet no one knows for sure if it is good, how it is good, or what it is good for, in terms of educational outcomes. We need to acquire such knowledge quickly, in order to help guide an innovation which is growing in the absence of research guidance.

What our study suggests, however, is that microcomputers per se will not promote particular outcomes. Their impact will depend, not only on hardware and software, but on how they are used and on the educational context within which they are embedded.

REFERENCES

Albin, P., Laudon, K., & Weinberg, A. Job complexities and automation: tobacco workers. Working paper, Center for the study of System Structure and Industrial Complexity, City University of New York, 1979.

Alter, S., & Ginzberg, M. Managing uncertainty in M.I.S. implementation. Sloan Management Review, 1978, 19, 23-31.

Anderson, N. B. The sociological implications of computer systems. In H. Smith & T. Green (Eds.), Man-computer research. London: Academic Press, 1979.

Anderson, N. B., & Jappe, L. Computer impact and the demand for participation. Paper presented at the IFIPS Conference on Human Choice and Computers, Vienna, June 1979.

Argyris, C. Personality and organization theory revisited. Public Administrative Review, 1973, 33, 141-167.

Bamberger, J. Developing a musical ear: a new experiment (Artificial Intelligence Memo No. 234). Cambridge: Massachusetts Institute of Technology A. I. Laboratory, July 1972.

Bell, D. The coming of post-industrial society: a venture in social forecasting. New York: Basic Books, 1973.

Bell, F. Classroom computers: beyond the 3 R's. Creative Computing, 1979, 5, 68-70.

Berman, P. & Pauly, E. Federal programs supporting educational change, Vol. II: factors affecting change agent projects. Santa Monica, Calif.: Rand Corporation, 1975.

Bork, A. Learning to teach via teaching the computer to teach. Journal of Computer-Based Instruction, 1975, 2.

Braverman, H. Labor and monopoly capital: the degradation of work in the twentieth century. New York: Monthly Review Press, 1974.

Briefs, U. The effects of computerization on human work. Paper presented at the IFIPS Conference on Human Choice and Computers, Vienna, June 1979.

Brzezinski, A. The technetronic society. New York: Atheneum, 1967.

Bunderson, C. V., & Faust, G. W. Programmed and computer-assisted instruction. In N. L. Gage (Ed.), The psychology of teaching methods: the seventy-fifth yearbook of the National Society for the Study of Education (Part 1). Chicago: University of Chicago Press, 1976.

Charters, W. W. & Pellegrin, R. Barriers to the innovation process: Four case studies of differentiated staffing. Administrative Science Quarterly, 1973, 9, 3-14.

Colton, K. (Ed.). Police computer technology. Lexington, MA: Lexington Books, 1978.

Danziger, J., & Dutton, W. H. Computers as an innovation in American local governments. Communications ACM, 1977, 20, 945-956.

Danziger, J., Dutton, W., Kling, R., & Kraemer, K. Computers and politics. New York: Columbia University Press, 1981. (forthcoming).

Downs, A. A realistic look at the final payoffs from urban data systems. Public Administration Review, 1967, 27, 204-210.

Dwyer, T. A. Soloworks: computer-based laboratories for high-school mathematics. School science and mathematics, 1975, 93-99.

Fullan, M. Overview of the innovative process and the user. Interchange, 1972, 3.

Fullan, M., & Pomfret, A. Research on curriculum and instruction implementation. Review of Educational Research, 1977, 47, 335-397.

Galbraith, K. The new industrial state. New York: New American Library, 1978.

Gerson, E. M., & Koenig, S. R. Information systems technology and organizations: the impact of computing on the division of labor and task organization. Working paper, Pragmatica Systems, San Francisco, 1979.

Goldstine, R. The computer from Pascal to von Neuman. Princeton: Princeton University Press, 1972.

Gross, N., Giacquinta, J. B., & Bernstein, M. Implementing organizational innovations. New York: Basic Books, 1971.

Hakansson, J., & Roach L. A dozen apples for the classroom. Creative Computing, 1979, 5, 52-54.

Hall, G. E., Wallace, R. C., Jr., & Dossett, W. F. A developmental conceptualization of the change process within educational institutions, Austin, Texas: Research and Development Center for Teacher Education, University of Texas at Austin, September, 1973.

House, E. The politics of educational innovation. Berkeley, Calif: McCutcan, 1975.

Keen, P. G. W., & Gerson, E. The politics of software systems design. Datamation, 1977, 23, 80-84.

Keen, P. G. W. & Morton, M. S. Decision support systems: an organizational perspective. Reading, MA: Addison-Wesley, 1978.

Kling, R. Computers and social power. Computers and Society, 1974, 5, 6-11.

Kling, R. Information systems and policymaking: computer technology and organizational arrangements. Telecommunications Policy, 1978, 2, 22-32.

Kling, R., & Scacchi, W. Recurrent dilemmas of computer use in complex organizations. Proceedings of the 1979 National Computer Conference (Vol. 48). Montvale, NJ: AFIPS Press, 1979, pp. 107-116.

Kraemer, K. L. Local government, information systems, and technology transfer. Public Administration Review, 1977, 37, 368-382.

Langenes, B. Computers: worlds of "if" for children to explore. Interface Age, 1978, 3, 68-69.

Laudon, K. Communications technology and democratic participation. New York: Praeger, 1977.

Laudon, K. Computers and bureaucratic reform. New York: Wiley-Interscience, 1974.

Laudon, K. Social impacts of a national computerized criminal history system. National Information Systems Study, United States Congress, Office of Technology Assessment, 1980.

Licklider, J. C. R. Impact of information technology on education in science and technology. In D. R. Deringer & A. R. Molnar (Eds.), Technology in science education: the next ten years. Washington, D.C.: National Science Foundation, 1979.

Licklider, J. C. R., & Vezza, A. Applications of information networks. Proceedings IEEE, 1978, 66, 1330-1346.

Lucas, H. Why information systems fail. New York: Columbia University Press, 1975.

Mann, F. C., & Williams, K. L. Observations on the dynamics of change to electronic data processing equipment. Administrative Science Quarterly, 1960, 5, 217-256.

Markus, M. L. Understanding information systems use in organizations: a theoretical explanation. Doctoral dissertation, Department of Organizational Behavior, Case Western Reserve University, Cleveland, Ohio, 1979.

Mesthene, E. G. Harvard University program on technology and society--final review. Cambridge: Harvard University Press, 1972.

Miles, M. B. (Ed.), Innovation in education. New York: Bureau of Publications, Teachers College, Columbia University, 1964.

Molnar, A.R. Viable goals for new educational technology efforts: science education and the new technological revolution. Paper presented at the annual meeting of the American Association for the Advancement of Science, New York, 1975.

Mowshowitz, A. The conquest of will: information processing in human affairs. Reading, MA: Addison-Wesley, 1976.

Mumford, E., & Banks, O. The computer and the clerk. London: Routledge & Kegan Paul, 1967.

Meyers, C. Computers in Knowledge-based fields. Cambridge: MIT Press, 1970.

Noble, D. America by design. New York: Knopf, 1977.

Nygaard, K. Workers' participation in system development. Paper presented at the IFIPS Conference on Human Choice and Computers, Vienna, June 1979.

Oettinger, A. G. Run computer run: the mythology of educational innovation. New York: Collier Books, 1969.

Office of Technology Assessment, United States Congress. Preliminary Assessment of the Tax Administration's System of the Internal Revenue Service, 1979.

Papert, S. Teaching children thinking (Artificial Intelligence Memo No. 247). Cambridge: Massachusetts Institute of Technology A. I. Laboratory, October 1971.

Pettigrew, A. M. The politics of organizational decision-making. London: Tavistock, 1973.

Quinsaat, M. B. Implementing computing technology in a classroom setting: an anecdotal report of long term use. Paper presented at the Institute of Education Planning Conference on Issues Related to the Implementation of Computer Technology in Schools, Washington, D.C., February 19, 1981.

Rule, J. B. Private lives & public surveillance. New York: Schocken Books, 1974.

Simon, H. A. The shape of automation for men and management. New York: Harper & Rowe, 1965.

Simon, H. A. The new science of management decision. Englewood Cliffs, N.J.: Prentice-Hall, 1977.

Sterling, T. Comsumer difficulties with computerized transactions: an empirical analysis. Communication ACM, 1979, 22, 283-289.

Suppes, P., & Morningstar, M. Computer assisted instruction at Stanford, 1966-68: data models and evaluation of arithmetic programs. New York: Academic Press, 1972.

Weizenbaum, J. Computer power and human reason. Cambridge: MIT Press, 1977.

Westin, A.F., Boguslaw, R., & Hoffman, L. Sociological objectives and requirements of the Social Security Administration's "Future Process". Design requirements for assuring the organizational and social responsiveness of a large-scale computer information system in the Social Security Administration. Baltimore: Social Security Administration, Office of Advanced Systems, 1979.

Westin, A. Privacy and freedom. New York: Athenum, 1968.

Westin, A., & Baker, D. Databanks in a free society. New York: Quadrangle, 1972.

Whisler, T. L. The impact of computers on organizations. New York: Praeger, 1970.

Wiener, N. The human use of human beings. New York: Harcourt, 1954.

Winner, L. Autonomous technology. Cambridge: MIT Press, 1977.

APPENDIX A: INTERVIEW GUIDES

GUIDE:

INTERVIEW FOR TEACHERS USING MICROPROCESSORS

Teacher_____ School_____

Class_____ Grade/Level_____

Interviewer_____

USE

1. How do you use microcomputers in your classroom?

   activities
   rules governing use
   software - source and adequacy
   control over use
   relationship to rest of curriculum
   problems

HISTORY

2. Describe the process by which computers were introduced in this school and the factors that influenced their diffusion in the school.

   early beginnings - who? why?
   source of funds
   formal/informal groups for decision-making
   role of teachers in the implementation process
   position of professional associations, unions
   role of state and local agencies
   role of hardware and software firms
   any new personnel?
   community support
   administrative support

GUIDE:
INTERVIEW FOR TEACHERS USING MICROPROCESSORS, cont.

EFFECTS

3. What are the effects of using micros for instruction?

1) students
   - academic achievement
   - cognitive development
   - social-emotional outcomes
     - (interest; motivation; self-concept)
   - peer relationships

   individual differences
   - those who benefit enormously
   - those who dislike computer
   - boys/girls
   - low-achievers/high-achievers

2) teacher
   - relationship with students
   - educational role in classroom
     - (do you teach differently because of computers)?

   teacher as worker
   - training
   - incentives
   - personal costs
   - source of support
     - resource centers
     - other teachers
     - other?

3) curriculum
   - goals
   - content

4. What kinds of issues within the school have shaped the instructional use of microcomputers?

   Have there been problems around
   - their use?
   - who uses
   - where placed
   - discipline; security

   Has there been active opposition to
   - the use of micros for instruction?
   - who?
   - why?

GUIDE:

INTERVIEW FOR TEACHERS USING MICROPROCESSORS, cont.

FUTURE

5. If you had unlimited resources, what would you want to happen in your classroom with microcomputers? What do you think will happen in the next five years?

6. If you were advising a teacher who was about to begin to use micros in the classroom, what advice would you give?

GUIDE:

INTERVIEW FOR TEACHERS WHO HAVE CHOSEN NOT TO USE MICROPROCESSORS

Teacher_____ School_____

Class_____ Grade/Level_____

Interviewer_____

1. Can you tell me about how microcomputers are presently being used in this school?

   subject matter areas
   selection of teachers
   applications
   administrative encouragement
     and support
   students reactions

2. Describe the process by which computers were introduced in this school system and the factors that influenced their diffusion in the schools.

   early beginnings - who? why?
     initial intent
   source of funds
   formal/informal groups fc .
     decision-making
   selection of teachers
   role of teachers in
     implementation process
   administrative support
   allocatcn of equipment
   community support

3. What are the benefits and drawbacks of the use of microprocessors? (source of information)

   equity
   efficiency
   quality education (define)
     has there been a change in
       the process or goals of
       education?
   remedial instruction
   individualized instruction
   computer literacy

GUIDE:

INTERVIEW FOR TEACHERS WHO HAVE CHOSEN NOT TO USE MICROPROCESSORS, cont.

4. What are your reasons for choosing not to use micros at this time?

Are there circumstances under which you might want to use them?

5. Given your thoughtful opposition, if you were responsbile for developing policy about the instructional use of micros, and had unlimited money and talented people, what would you do?

GUIDE:

INTERVIEW FOR COMMUNITY LEADERS INTERESTED IN MICROCOMPUTER POLICIES

Name_____ Organization_____

Position_____ Interviewer_____

HISTORY

1. What has been your role (or the role of your organization) in influencing the use of microcomputers in the public schools?

   early beginnings - who
     involved; goals and reasons?
   diffusion
   motivations for involvement
   role in other innovations
   special expertise?

USE

2. How and where are microcomputers used in the school system?

3. What are the benefits and drawbacks of the use of microcomputers in the schools?

   school system
   teachers
   students

CONTEXT

4. Over the last few years, what factors have been influential in shaping school policy in this community?

   demography - populations served
     population changes -
       size
       minority groups
       socio-economic status
   local employment opportunities
   goals for public education -
     diversity
   economy - in general
     specifically - budget/taxes
   general attitude toward
     innovation

5. Have these factors had any impact on the allocation or use of microcomputers in the schools?

6. In the last five years, what were some of the principal issues between community groups and the schools?

   who was involved:

   issue - economic issues
   curriculum content
   school discipline
   pupil assignment to school
   budgets
   union negotiations

7. Have these issues influenced the use of computers in any ways?

   specify active groups or individuals

FUTURE

8. Looking to the future, how do you expect computers will be used in your school system in five years?

   influencing factors
   allocation, diffusion
   changes in educational values
   (e.g., interest in math, science)
   changes in authority relationships

9. If you could plan for the use of microcomputers in a school system with unlimited resources, what plans would you make?

GUIDE:

INTERVIEW FOR MEMBERS OF THE BOARD OF EDUCATION

Name_____ Board_____

Interviewer_____

HISTORY

1. How did the instructional use of microcomputers get started in this community?

   early beginnings - individuals
     involved, motivations,
     initial intent
   diffusion
   role of state and local
     educational agencies
   role of public and
     private institutions
   role of computer hardware
     and software firms
   involvement of computer-
     skilled professionals
     from the community

2. What has been the role of the School Board in developing a computer program in the schools?

   oversight relationship
   budget considerations
   typical of role in innovations?
   attitudes of individual board
     members

USE

3. How and where are microcomputers used in the school system at the present time?

   allocation
   uses - remedial instruction
          individualized instruction
          computer literacy

CONTEXT

4. Over the last few years, what major factors have been influential in shaping school policy in this community?

   demography - populations served
   population changes -
   size
   minority groups
   socio-economic status
   local employment opportunities
   goals for public education -
   diversity
   economy - in general
   specifically budget/taxes
   general attitude toward
   educational innovation

5. Have these factors had any impact on the allocation or use of microcomputers in the schools?

6. In the last five years, what were some of the principal issues between community groups and the schools?

   economic issues
   curriculum content
   school discipline
   pupil assignment to schools
   union negotiations
   general relationships between
   BOE, administration and teachers

7. Have these issues influenced the use of microcomputers in any ways?

   specify active groups or individuals

8. What have been the benefits and drawbacks of using microcomputers in the schools?

    school system
    teachers
    students

FUTURE

9. Looking to the future, how do you expect microcomputers will be used in your school system in five years?

    allocation; diffusion
    changes in education values
      (e.g.,. interest in math,
      science)
    role of state and local
      agencies
    role of hardware and
      software firms
    changes in authority
      relationships
    personnel

    tie-in with answer to #8 if appropriate

10. If you could plan for the use of microcomputers in a school system with unlimited resources, what plans would you make?

GUIDE:
INTERVIEW FOR DISTRICT ADMINISTATORS

Name_____ District_____

Position_____ Interviewer_____

USE

1. How are microcomputers being used in your school system?

purpose: remedial instruction
individualized instruction
computer literacy
schools served
pupils served
subject areas

HISTORY

2. How did the program come about?

beginnings - who involved,
initial intent
community support
groups for decision making -
formal/informal
teacher training
representation of
various schools
role of teachers in
implementation process
(software; hardware)
role of state and local agencies
role of hardware and
software firms
position of professional
associations, unions
any new personnel

3. How is the program financed?

Initial source of funds -
budget increase; trade
off; extra funds

Continuing source of funds

Allocation of monies within program
hardware
software
training

Who are the recipients and how is
it decided?

4. Describe the factors that influenced which schools and teachers became involved with computers and which did not.

EFFECTS

5. What are the effects of the use of microcomputers on

   a) administration
      functions
      broad educational goals
      budgets

   b) teachers
      working conditions -
        role change
      training

   c) students
      interest in particular
        disciplines
      equity
      parents' attitudes

6. How do you feel about the impact of microcomputers in your school system?

   schools
   teachers
   students

7. What are the factors in the relationship between the schools and the community which influenced the use of computers?

   general economy - budget and
     taxation in particular
   changing enrollment - numbers;
     populations served
   employment opportunities
   interest in computers

   existing conflicts -
     curriculum content
     school discipline
     assignment of pupils to schools

FUTURE

8. What do you envision as the future of microcomputers in your school system in the next five years? Describe both positive and negative possibilities and the conditions that will promote positive outcomes.

9. If you could plan for microcomputer implementation in a school system with unlimited resources, what would you do?

GUIDE:
INTERVIEW FOR SCHOOL ADMINISTRATORS

Name_____ School_____

Position_____ Interviewer_____

USE

1. How are microcomputers being used in your school?

purpose: remedial instruction
individualized instruction
computer literacy
pupils served
subject areas

HISTORY

2. How did the program come about?

beginnings - who involved,
initial intent
community support
groups for decision making -
formal/informal
teacher training
role of teachers in
implementation process
(software; hardware)
role of [illegible]te and local
agencies
role of hardware and
software firms
position of professional
associations, unions
any new personnel

3. How is the program financed?

Initial source of funds -
budget increase; trade
off; extra funds

Continuing source of funds -

Allocation of monies within program
hardware
software
training

Who are the recipients and how is
it decided

4. Describe the factors that influenced which teachers became involved with computers and which did not.

EFFECTS

5. What are the effects of the use of microcomputers on

   a) administration
      functions
      broad educational goals
      budgets

   b) teachers
      working conditions -
        role change
      training

   c) students
      interest in particular
        disciplines
      equity
      parents' attitudes

6. How do you feel about the impact of microcomputers in your school?

   school
   teachers
   students

7. What are the factors in the relationship between the school and the community which influence the use of computers?

   general economy - budget and
     taxation in particular
   changing enrollment - numbers;
     populations served
     employment opportunities
     interest in computers?

     existing conflicts -
       curriculum content
       school discipline
       assignment of pupils to schools

GUIDE:
INTERVIEW FOR SCHOOL ADMINISTRATORS, cont.

FUTURE

8. What do you envision as the future of microcomputers in your school in the next five years? Describe both positive and negative possibilities and the conditions that will promote positive outcomes.

9. If you could plan for microcomputer implementation in a school with unlimited resources, what would you do?

GUIDE:

INTERVIEW FOR STUDENTS

Student_____ School_____

Class_____ Grade/Level_____

Interviewer_____

USE

1. In what ways is the microcomputer used in your class?

   activities
   fit with the rest of the class
   monitoring of work
   is what was observed typical
     of its use?

2. Who uses the computer?

   number of students
   time
   equity
     boys/girls
     high-achievers/low-achievers
   do students have choices
     about when and how it's used?
   computer sub-culture - uses on
     weekends and after school

3. Do you use microcomputers in other classes or as part of your extra-cirricular activities? If so, what kinds of things do you do with the computer?

   activities
   amount of time
   required/not required

EFFECTS

4. How do you feel about working with the computer?

   motivation; persistance
   attitudes toward subject matter
   durability of hardware
   do some students dislike it? -
     Why?

GUIDE:
INTERVIEW FOR STUDENTS, cont.

EFFECTS

5. How is the teaching in classes with microcomputers different from the teaching in classes where computers aren't used?

   instructional goals
   (problem-solving; drill)
   student-student interaction
   (collaboration; competition)
   teacher-student relationships -
   authority

   do students develop software
   or teach others to use the
   equipment?

6. What have you learned through working with a microcomputer?

   academic achievement
   cognitive development - problem
   solving; analysis
   social/emotional development

   Are there things that you think
   you could learn better from
   a computer than from a
   teacher?

   Are there things that you think
   you could learn better from
   a teacher than from a
   computer?

   Have you learned any skills
   through using the
   computer that you use
   in other courses?

7. What are the advantages and disadvantages in using computers as one way of helping students learn?

APPENDIX B: CLASSROOM OBSERVATION

Classroom Observation Observer_____

Teacher_____ School_____

Class_____ Grade/Level_____ Date/Time_____

No. of Micros_____ Type_____

Class Composition: Boys_____ Girls_____ Achievement Level_____

Ethnic Representation: B_____ H_____ C_____ A_____ Other_____

1. a) Diagram the room arrangement, indicating the placement of micros (X), students (O) and teacher (△). If the teacher circulates, indicate by placing an arrow beneath the triangle.

b) Who is using the computer?

_____part of the class

_____individual students working alone

_____small groups of students working together

_____the whole class

_____teacher/student giving demonstration

_____each student at own machine

_____small groups of students at each machine

After observing computer-related activity in a classroom for 15-20 minutes, answer the following questions. Along with each answer, provide anecdotal evidence which illustrates the basis of your answer.

2. What is the purpose of the computer-based activity?

3. What is the nature of the computer-based activity?

_____simulation
_____drill and practice
_____tutorial
_____games
_____programming
_____diagnostic/prescriptive
_____testing
_____computer literacy

4. How many students were directly working with computers (indicate sex, judged ethnicity, judged achievement level.

early in class period	middle of class period	end of class period

5. In which ways is the computer-based activity individualized for students?

_____individualized courseware
_____difficulty level
_____pacing
_____self-initiated projects

6. What is the major role of the teacher?

_____presenting information
_____eliciting information
_____responding to students' questions
_____encouraging reasoning and problem solving
_____managing machine use

7. How does the teacher direct/support the students' work with the computer?

8. a) Do students work together or independently on the computer-related work? Do they have a choice about working together or independently?

b) If they are working together, are the interactions positive or negative?

9. How do students seem to feel about working with computers?

enthusiastic interested accepting bored frustrated resistant

10. How does the teacher seem to feel about working with computers?

enthusiastic interested accepting bored frustrated resistant

11. Is the computer work related to other curricular activities? How?

12. Are there any observable hardware, software, or use problems?